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No. 640

RECORD

United States Court of Appeals

FOR THE EIGHTH CIRCUIT

Nos. 15,725 and 15,729
CIVIL

BRIGGS & STRATTON CORPORATION,
Appellant,

vs.

CLINTON MACHINE CO., INC.,
Appellee.

CLINTON MACHINE CO., INC.,
Cross-Appellant,

vs.

BRIGGS & STRATTON CORPORATION,
Cross-Appellee.

Appeals from the United States District Court for the Northern District of Iowa

VOLUME III
Patent Copies

HAMMERSMITH-KORTMEYER CO.
MILWAUKEE

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Wacker	1,224,247	P-77
Winkels et al	2,375,718	P-353

No. 615,766. Patented Dec. 13, 1898.

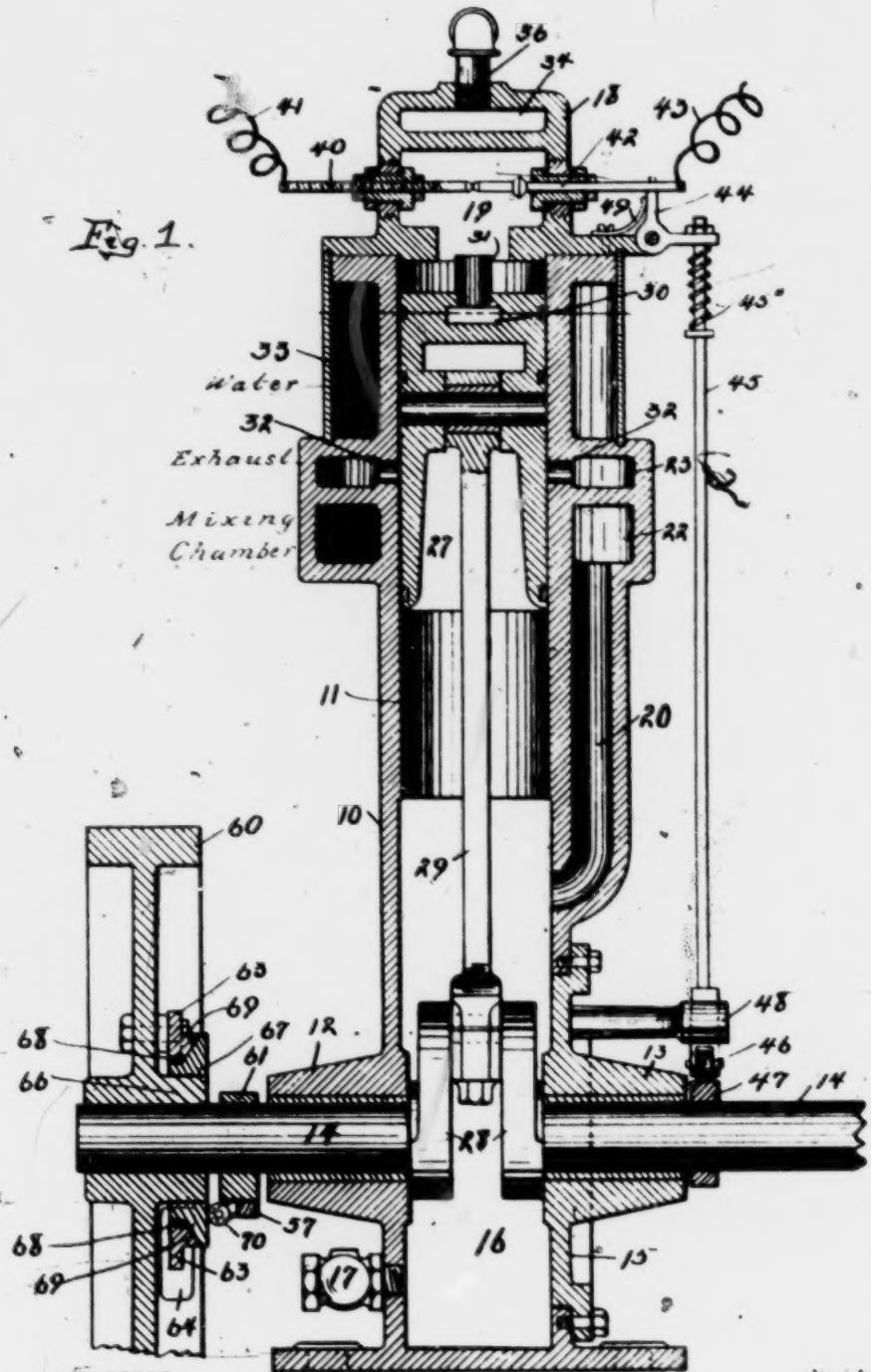
A. A. VANSICKLE.

GAS ENGINE.

(Application filed Apr. 27, 1897.

(No Model.) 3 Sheets—Sheet 1.

Fig. 1.



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No. 615,768. Patented Dec. 13, 1898.

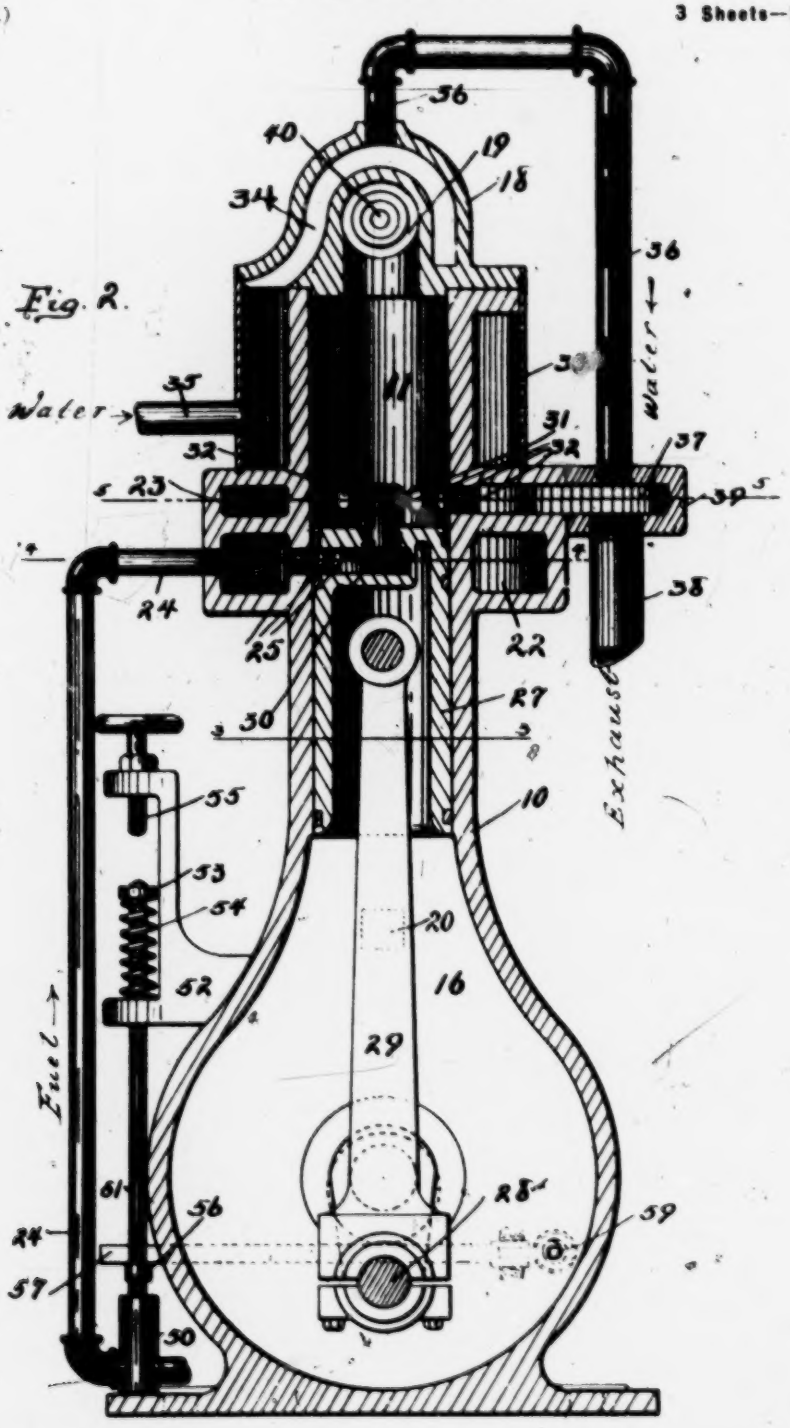
A. A. VANSICKLE.

GAS ENGINE.

(Application filed Apr. 27, 1897.)

(No Model.) 3 Sheets—Sheet 2.

Fig. 2.



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GAS ENGINE.

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Fig. 5.

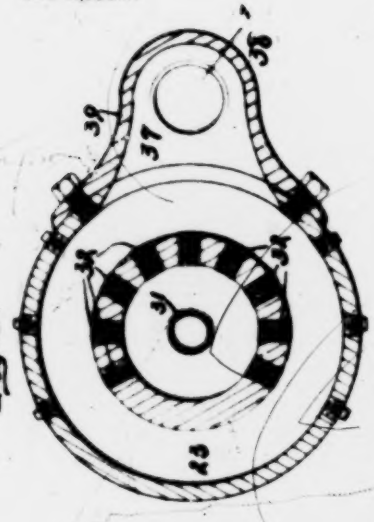


Fig. 7.

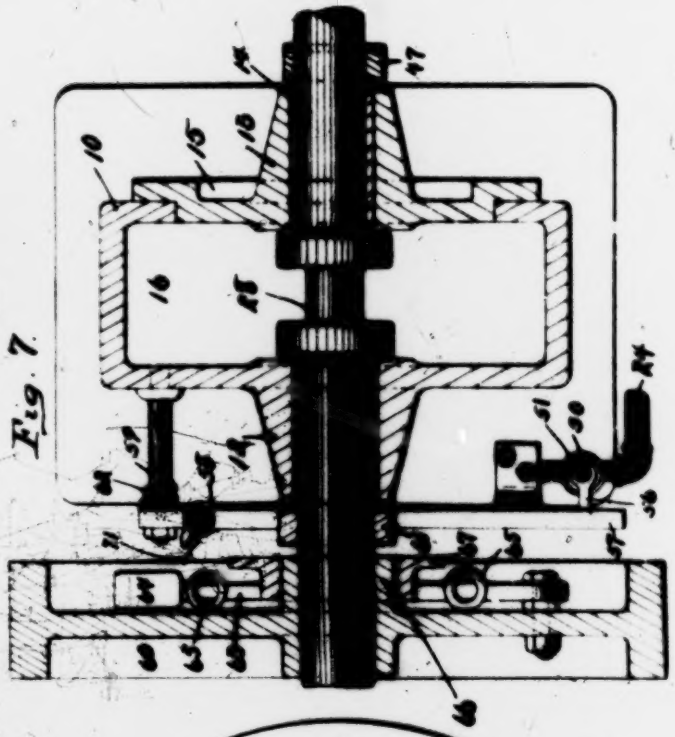


Fig. 4.

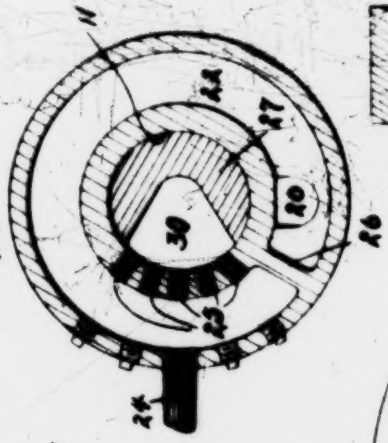
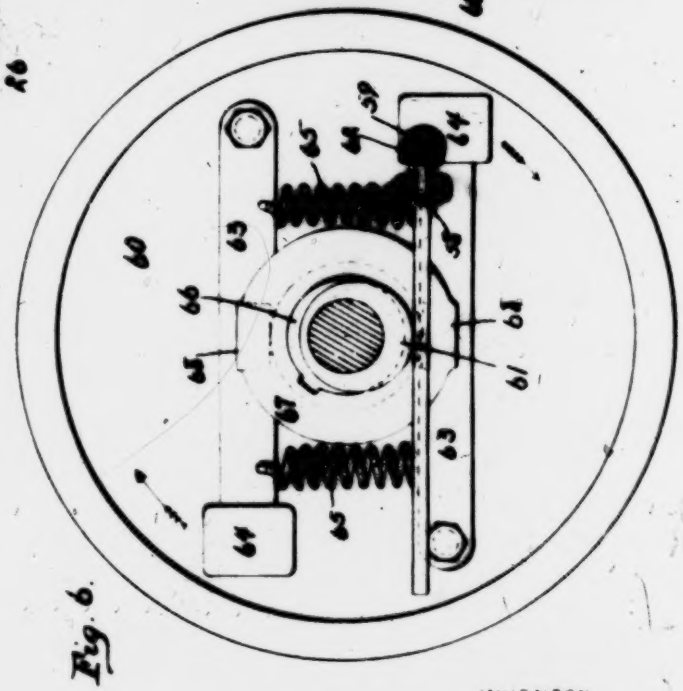


Fig. 3.

Fig. 6.



WITNESSES

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UNITED STATES PATENT OFFICE.

ALEXANDER A. VANSICKLE, OF INDIANAPOLIS, INDIANA, ASSIGNOR OF TWO-THIRDS TO THOMAS MORRIS DEFREES, OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 615,766, dated December 13, 1898.

Application filed April 27, 1897. Serial No. 634,100. (No model.)

To all whom it may concern:

Be it known that I, ALEXANDER A. VANSICKLE, a citizen of the United States, residing at Indianapolis, in the county of Marion and State of Indiana, have invented certain new and useful Improvements in Gas-Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to an improvement in gas-engines.

The objects of my invention are to produce an engine in which the movement of the piston will operate to open and close the exhaust and admission ports, to provide means for allowing a rapid exhaust, to provide means by which the explosive mixture may be heated prior to its admission into the cylinder by the exhaust-gases, to provide an improved form of governor to regulate the flow of gas or petroleum, and to provide the various details of construction hereinafter pointed out.

The accompanying drawings illustrate my invention.

Figure 1 is a central vertical section parallel with the crank-shaft. Fig. 2 is a similar section at right angles to the crank-shaft. Fig. 3 is a horizontal section on line 3 3, Fig. 2. Fig. 4 is a similar section on line 4 4, Fig. 2. Fig. 5 is a similar section on line 5 5, Fig. 2. Fig. 6 is a side elevation of the governor. Fig. 7 is a horizontal section through the crank-shaft.

In the drawings, 10 indicates a casting the upper end of which is bored out to form the cylinder 11. Formed near the lower end of casting 10 are two bearings 12 and 13, which are adapted to receive the crank-shaft 14, one of said bearings being preferably carried by a cap 15, bolted to one side of casting 10, the arrangement being such that by removing cap 15 the interior of the casting 10 may be reached and the various portions of the crank-shaft and attached parts may be easily assembled. The lower portion of casting 10 forms a chamber 16, which is air-tight, and for the purpose of admitting air to the interior thereof I provide a check-valve 17. The upper end of cylinder 11 is closed by a cap 18, provided with a chamber 19, communicating with the interior of the cylinder and in which the igniting means is mounted.

Leading from chamber 16 up alongside the lower end of cylinder 11 to about the middle thereof is an air-duct 20, the upper end of which opens into an annular mixing-chamber 22, which surrounds the cylinder. Immediately above chamber 22 is a similar chamber 23, into which the exhaust is discharged, the arrangement being such that the heat from the exhaust-gases will serve to heat the material within the mixing-chamber 22. Leading into chamber 22 at a point about ninety degrees from the air-duct 20 is a pipe 24, which is connected with any suitable supply of fuel.

It will be understood, of course, that within pipe 24 may be mounted any suitable spraying device in case a liquid fuel is used. Leading through the walls of cylinder 11 at a point opposite the inner end of pipe 24 is a series of openings 25, and placed between these openings and the air-duct 20 is a partition 26, the arrangement being such that the air from duct 20 must pass entirely around the cylinder before reaching openings 25.

Mounted within cylinder 11 is a piston 27, which is connected with the crank 28 of crank-shaft 14 by means of a pitman 29. Formed in the upper end of piston 27, a short distance from the end and at right angles to the axis thereof, is a V-shaped slot 30, the inner end of which extends to the center of the piston, the arrangement being such that the outer wider end embraces and communicates with the inner ends of openings 25 when the piston is at the end of its forward stroke. Secured to the top of piston 27 and communicating with the inner end of slot 30 is a pipe 31, the purpose of which will be made to appear.

Leading from the interior of cylinder 11 into chamber 23 is a series of exhaust-ports 32, which are placed as near together as possible around the circumference of the cylinder, with the exception of the short space along which the mouth of slot 30 travels.

Around the upper end of cylinder 11 is

formed a water-jacket 33, the upper end of which communicates with a water-space 34, formed in cap 18 and surrounding chamber 19. Leading into jacket 33 is a suitable supply-pipe 35, and leading from space 34 is a discharge-pipe 36. For the purpose of forcing the exhaust-gases from the chamber 23 the said chamber is extended, as at 37, and the outer end of pipe 36 leads therein. Opposite pipe 36 and leading from chamber 37 is a discharge-pipe 38, which is of considerably larger diameter than pipe 36 and is adapted to receive the exhaust-gases and the discharged water from the water-jackets, the arrangement being such that the passage of the water through chamber 37 draws the gases from chamber 23. Extension 37 may be formed integral with chamber 36, or it may be formed by means of a cap 39, bolted to the side of said chamber.

Leading into chamber 19 and insulated therefrom is an adjustable electrode 40, connected by wire 41 with any suitable battery, and leading into chamber 19, opposite electrode 40, is a sliding electrode 42, connected by wire 43 with said battery. Electrode 42 may be longitudinally moved through its bearings and alternately brought into contact with and separated from electrode 40 by means of a lever 44, to one arm of which is secured a rod 45, on the lower end of which is mounted a roller 46, which rests upon a cam 47, carried by the crank-shaft 14. Rod 45 is supported by a suitable bearing 48, and mounted between the said arm and the lever 44 is a spring 45', which will yield when the ends of the electrodes are in engagement. Roller 46 is held in engagement with cam 47 by means of a spring 49, which engages one arm of lever 44.

For the purpose of automatically regulating the amount of fuel supplied to the cylinder I mount at a convenient point in pipe 24 a pump 50, to the piston of which is secured a rod 51, the upper end of which is supported by a suitable bearing 52, between which and a collar 53, carried by the upper end of rod 51, is mounted a spring 54, which tends to normally hold the piston at the extreme of its backward stroke. In order to regulate the movement of the piston of the pump, I provide an adjustable stop 55, adapted to engage the upper end of rod 51. Secured to the rod 51 is a step 56, which is engaged by the outer end of a lever 57. Lever 57 is provided with a joint 58, allowing the outer end to swing in a plane parallel with the step 56, and the said lever is pivoted at 59, so as to swing in a plane parallel with the pump piston-rod and also parallel with the side of a fly-wheel 60, secured to shaft 14. Lever 57 lies at right angles to shaft 14 and is engaged by a cam 61, secured thereto, being held in engagement with said cam by means of a spring 62, placed, if desired, around pivot 59. Pivoted to wheel 60, so as to swing in a plane at right angles to shaft 14, are two arms 63, each provided at its outer end with a weight 64. The pivotal points of arms 63 are diametrically opposed, and the two arms are connected together by a pair of spiral springs 65, the said springs opposing any outward-swinging movement of the arms. Arms 63 pass upon opposite sides of hub 66 of wheel 60, and keyed on this hub and longitudinally movable thereon is a collar 67, provided with a pair of diametrically-located inclined recesses 68, in each of which rests an inclined lug 69, carried one by each of arms 63, the arrangement being such that as the outer ends of arms 63 swing outward collar 37 may be forced outward away from cam 61. For the purpose of causing this movement of collar 67 lever 57 is provided with a roller 70, which engages the outer side of collar 67, and a suitable spring 71 is provided to force said roller against the collar. Spring 71 may be placed around the pivot of joint 58, or, if desired, it may be secured to the casting 10, with its free end in engagement with lever 57.

The operation is as follows: The piston being caused to descend in the cylinder, the air in chamber 16 is forced through duct 20 into chamber 22 and around the cylinder. At the same time, slot 30 having been brought opposite openings 25, lever 57 is forced by cam 61 into engagement with step 56 and the piston of the pump 50 is forced forward against the action of spring 54, thus forcing a charge of fuel through pipe 24 and into the mixing-chamber, where it becomes mixed with the heated air already in said chamber, and owing to the pressure of the air within chamber 16 and the mixing-chamber 22, with which it is at all times in communication, the mixture is forced through openings 25 into slot 30 and from there up through pipe 31 into the upper end of cylinder 11, the mixture also rising into chamber 19 around the electrodes 40 42. A continued movement of the crank-shaft causes the piston to move upward, thus closing openings 25 and compressing the mixture in the upper end of the cylinder. When the piston reaches the end of its backward stroke, the electrodes 40 42, which have been previously brought together by the action of cam 47, rod 45, and lever 44, are suddenly separated by the action of said parts, a spark is formed, and the compressed mixture is exploded, thus driving the piston forward. During the backward stroke of the piston a fresh quantity of air is drawn into chamber 16 through check-valve 17, and the pump-piston is returned to its normal position by spring 54. As the piston passes forward and nears the end of its forward stroke the exhaust-ports 32 are uncovered and the exploded gases are quickly discharged therethrough into the exhaust-chamber 23, from which they pass to pipe 38. A continued movement of the piston brings the outer end of slot 30 opposite openings 25, the piston of pump 50 is again operated by the action of cam 61 and lever 57, and a fresh charge of

fuel and air is forced through openings 25, slot 30, and pipe 31. The continued movement of the crank-shaft carries the piston back, the admission and exhaust ports are closed thereby, the mixture in the upper end of cylinder 11 is compressed, a fresh supply of air is drawn into chamber 16, and the operation is repeated. As the speed of the engine increases the weighted ends of arms 63 fly outward, thus partially withdrawing lugs 69 from recesses 68, so that collar 67 may be forced outward by lever 57 and spring 71, this movement, if sufficient, allowing the outer end of lever 57 to swing away from step 56 and miss it as the lever is forced downward by the cam 61. It will be understood, of course, that if gas under pressure be used instead of a liquid fuel a valve may be substituted for pump 50.

It is to be noticed that pipe 31 extends slightly above the exhaust-ports 32 and that it is located substantially in the axis of the cylinder, so that the incoming fuel does not become appreciably mixed with the outgoing dead gases. Again, the exhaust-ports leading into a chamber of comparatively large capacity and the said ports leading from all points around the circumference of the cylinder the exhaust is very rapid and noiseless and the greater portion of the dead gas passes into the exhaust-chamber before the piston passes forward enough to open the admission-ports and allow the entrance of the fresh mixture.

I claim as my invention—

1. In a gas-engine, the combination with the cylinder and the piston, of an exhaust-chamber surrounding the cylinder, ports leading from said cylinder into said chamber and arranged to be opened and closed by the piston, a mixing-chamber surrounding the cylinder, and ports leading from said chamber into the cylinder and arranged to be opened and closed by the piston, substantially as described.

2. In a gas-engine, the combination with the cylinder and the piston, of an exhaust-chamber surrounding the cylinder, ports leading from said cylinder into said chamber and arranged to be opened and closed by the piston, a mixing-chamber surrounding the cylinder immediately beneath the exhaust-chamber, and ports leading from said mixing-chamber into the cylinder and arranged to be opened and closed by the piston, substantially as described.

3. In a gas-engine, the combination with the cylinder, of an annular exhaust-chamber surrounding the cylinder, and an annular mixing-chamber surrounding the cylinder and placed adjacent the exhaust-chamber, the arrangement being such that the contents of the mixing-chamber will be heated by the exhaust, substantially as described.

4. In a gas-engine, the combination with the cylinder and piston, of an air-chamber formed upon one side of said piston, an annular mixing-chamber surrounding the cylinder and in constant communication with said air-chamber, means for introducing fuel into said mixing-chamber, a port leading from said mixing-chamber into the cylinder, the arrangement being such that the port will be opened and closed by the piston, and means for allowing the escape of the dead gas, substantially as described.

5. In a gas-engine, the combination with the cylinder and piston, of an air-chamber formed upon one side of said piston, an annular mixing-chamber surrounding the cylinder and in constant communication with the air-chamber, means for introducing fuel into said mixing-chamber, a port leading from said mixing-chamber into the cylinder, the arrangement being such that the port will be opened and closed by the piston, an annular exhaust-chamber adjacent the mixing-chamber and surrounding the cylinder, and a series of ports leading from the cylinder to said exhaust-chamber, substantially as and for the purpose set forth.

6. In a gas-engine, the combination with the cylinder and piston, of an air-chamber formed upon one side of the piston, a mixing-chamber in constant communication with said air-chamber, means for introducing fuel into said mixing-chamber, a port leading from said mixing-chamber into the cylinder, a slot formed in the periphery of the piston and leading into the piston, and a pipe forming a connection between the inner end of said slot and the interior of the cylinder, the arrangement being such that, when the piston is at one end of its stroke, the outer end of said slot will be brought opposite the port, substantially as described.

7. In a gas-engine, the combination with the cylinder and piston, of an air-chamber formed upon one side of the piston, an annular mixing-chamber surrounding the cylinder and in constant communication with said air-chamber, means for introducing fuel into said mixing-chamber, a port leading from said chamber into the cylinder, a slot formed in the periphery of the piston and leading into the piston, a pipe forming a connection between the inner end of the slot and the interior of the cylinder, the arrangement being such that, when the piston is at one end of its stroke, the outer end of said slot will be brought opposite the port, an annular exhaust-chamber surrounding the cylinder adjacent the mixing-chamber, and a series of ports leading from the cylinder into said exhaust-chamber, substantially as described.

8. In a gas-engine, the combination with an exhaust-chamber adapted to receive the exhaust from the engine-cylinder, and a water-jacket surrounding a portion of the cylinder, of a pipe leading from said water-jacket into said chamber, and a second pipe, mounted opposite the discharge end of said first pipe and leading from said chamber, the said

second pipe receiving the material passing through the first pipe, substantially as and for the purpose set forth.

9. In a gas-engine, the cylinder, a piston mounted therein, a mixing-chamber, one or more ports leading through the wall of the cylinder from the interior of said cylinder into said mixing-chamber, a V-shaped, substantially-radial slot formed in the piston, and a communicating passage between the inner end of said slot and the interior of the cylinder, the arrangement being such that, when the piston is at one end of its stroke, the outer end of said slot will lie opposite the said port or ports, substantially as described.

10. In a gas-engine, the combination with the crank-shaft, of a wheel rotated thereby, an arm pivoted to said wheel so as to swing in a plane at right angles to the shaft, a collar keyed to the shaft and longitudinally movable thereon, inclined coacting surfaces carried by said arm and collar, a lever adapted to engage said collar and hold it in engagement with the arm, a cam arranged to engage the lever and to operate the same at right angles to the movement of the collar, and fuel-controlling means arranged to be normally engaged by said lever, the arrangement being such that, when the arm swings outward, the lever will be withdrawn from engagement with said fuel-controlling means, substantially as described.

11. In a gas-engine, the combination with the crank-shaft, of a wheel rotated thereby, an arm pivoted to said wheel so as to swing in a plane at right angles to the shaft, a collar keyed to the shaft and longitudinally movable thereon, inclined coacting surfaces carried by said arm and collar, a lever pivoted to swing in a plane at right angles to the shaft, a joint in said lever allowing the outer end thereof to swing in a plane parallel with the shaft, means carried by the outer end of said lever for engaging the collar and for holding it in engagement with the arm, and fuel-controlling means arranged to be normally engaged by the outer end of said lever, the arrangement being such that, when the arm swings outward, the lever will be withdrawn from engagement with said fuel-controlling means, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

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No. 740,781. PATENTED OCT. 6, 1903.

T. L. & T. J. STURTEVANT.

ELECTRICAL SPARKING IGNITER FOR GAS ENGINES

APPLICATION FILED OCT. 9, 1901.

NO MODEL 5 SHEETS—SHEET 1.

Fig. 1.

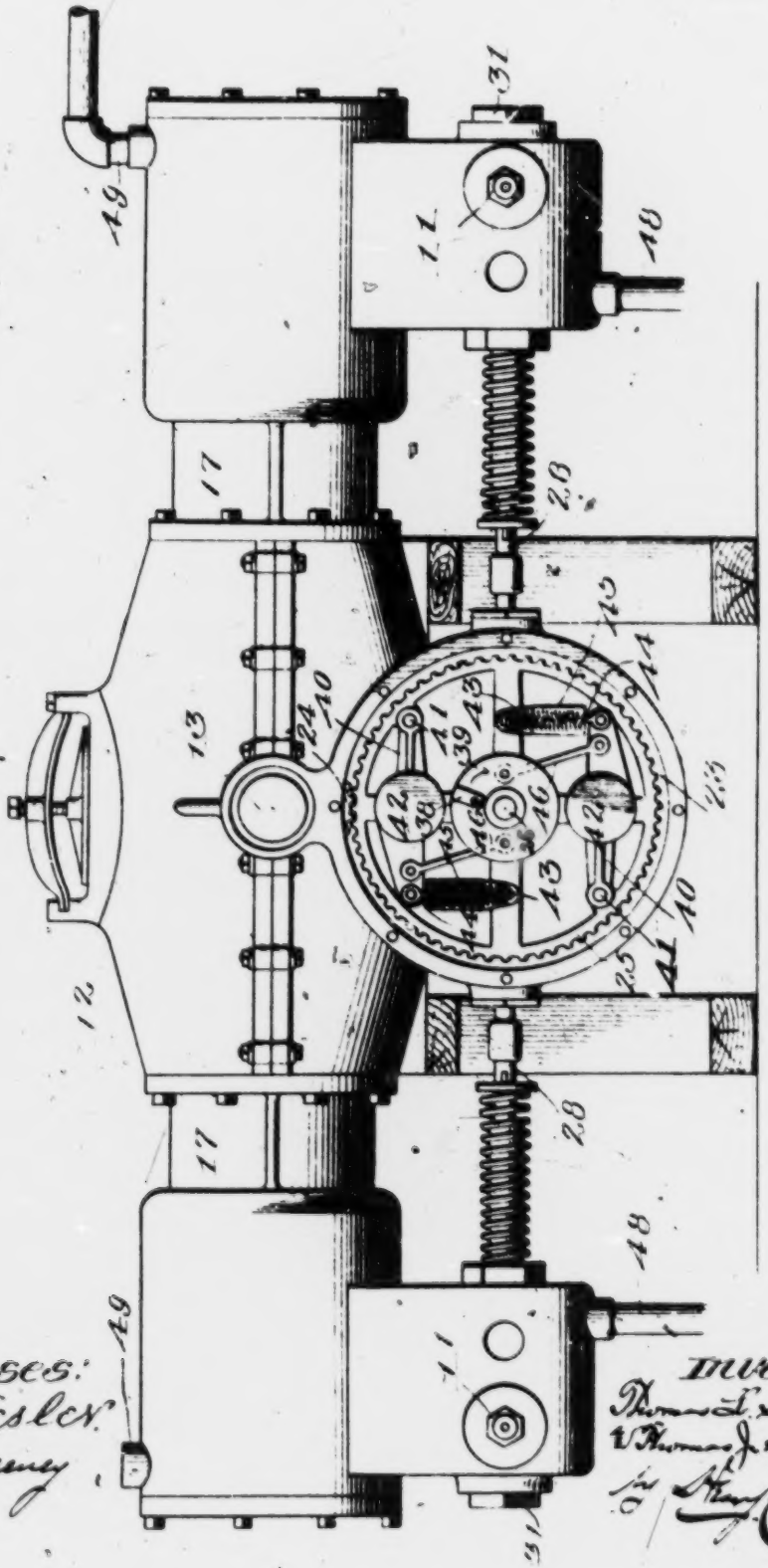

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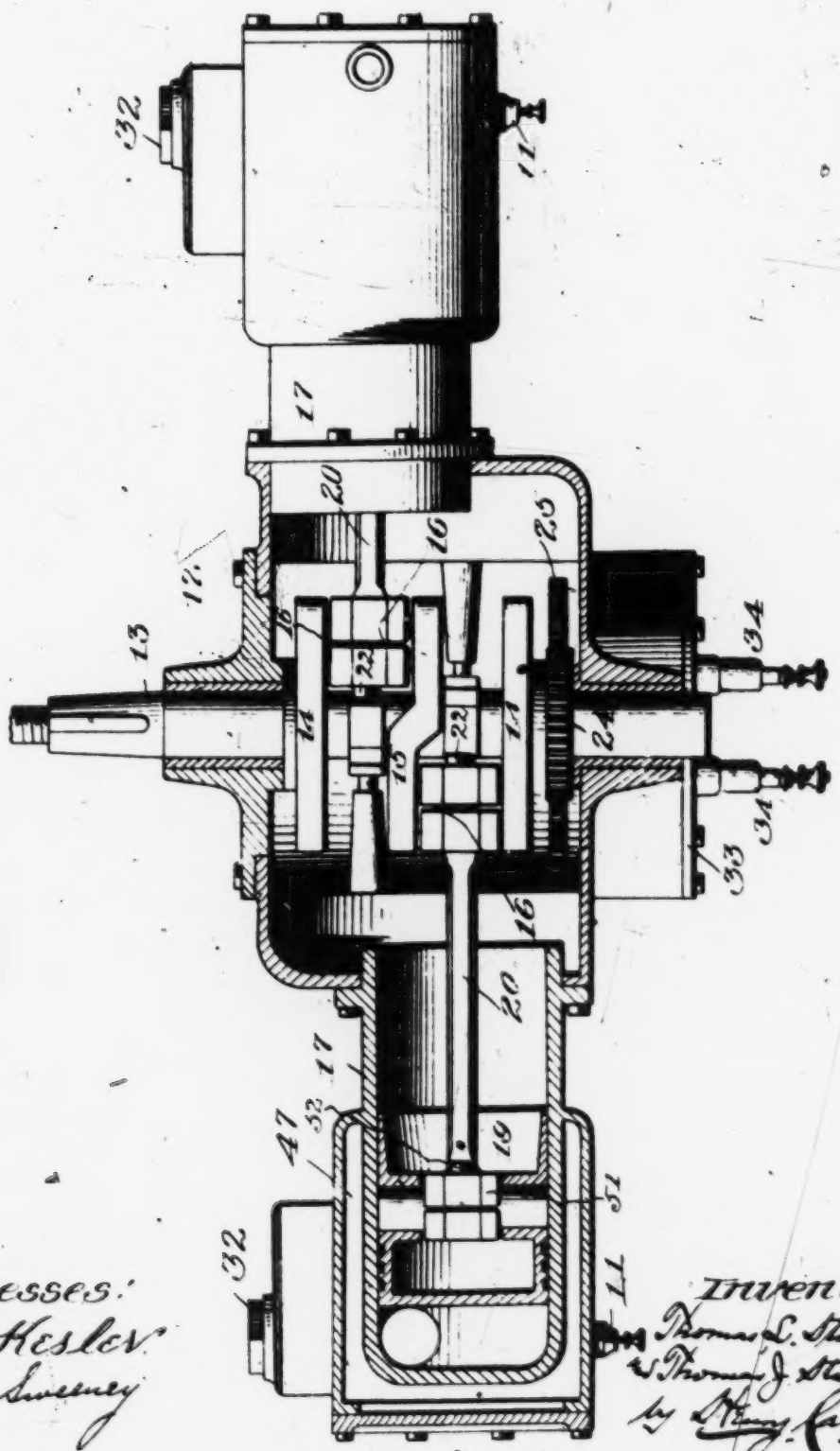
Fig. 2.



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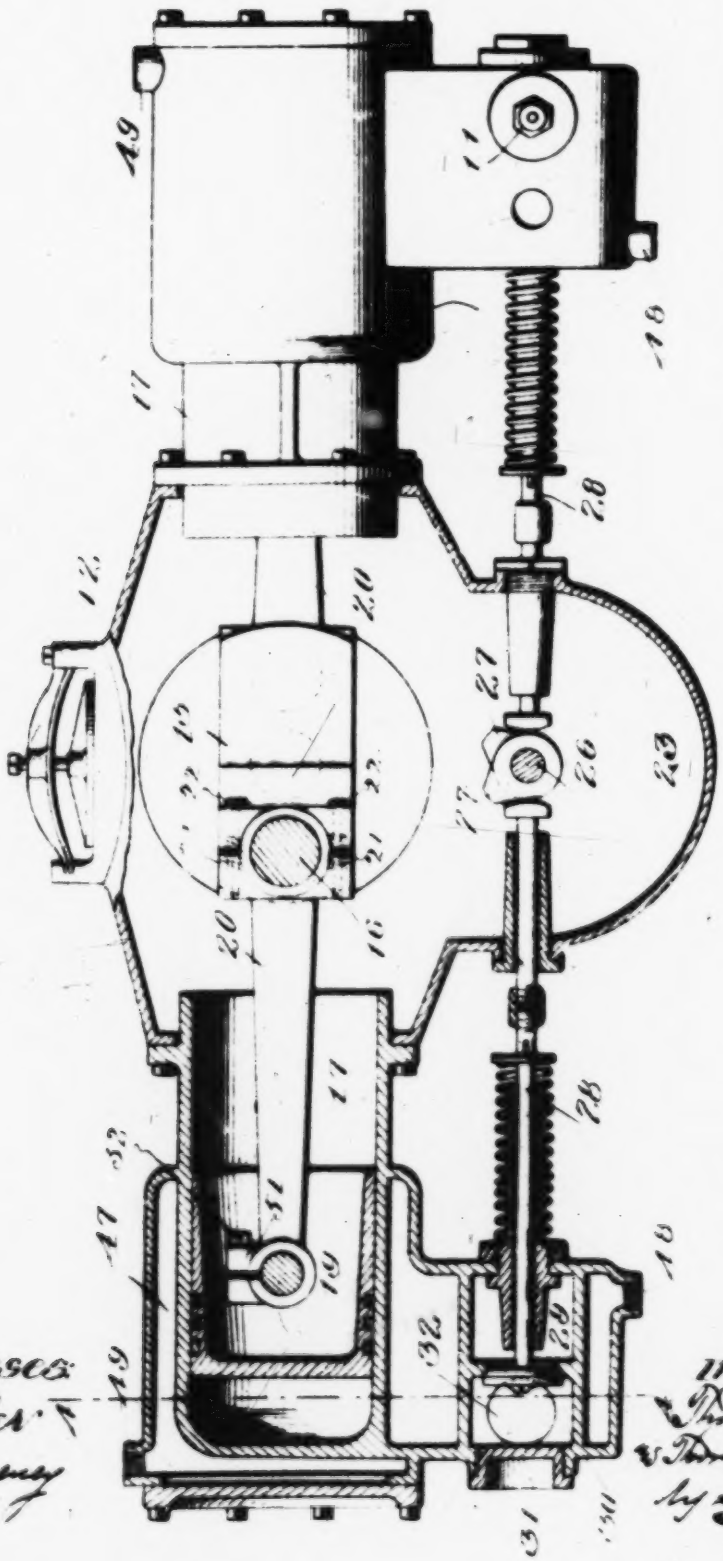
APPLICATION FILED OCT. 9, 1901.

NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.



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APPLICATION FILED OCT. 9, 1901.

NO MODEL. 5 SHEETS—SHEET 4.

Fig. 4.

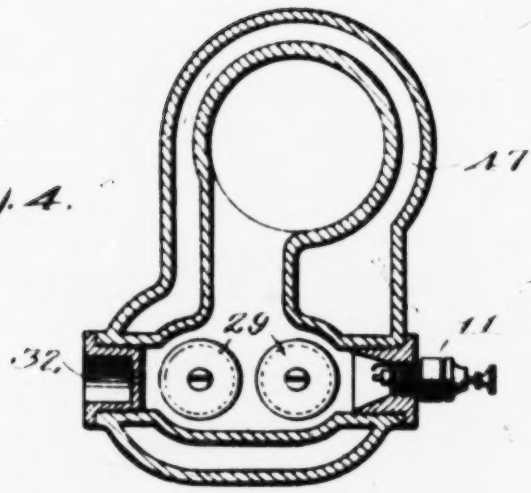
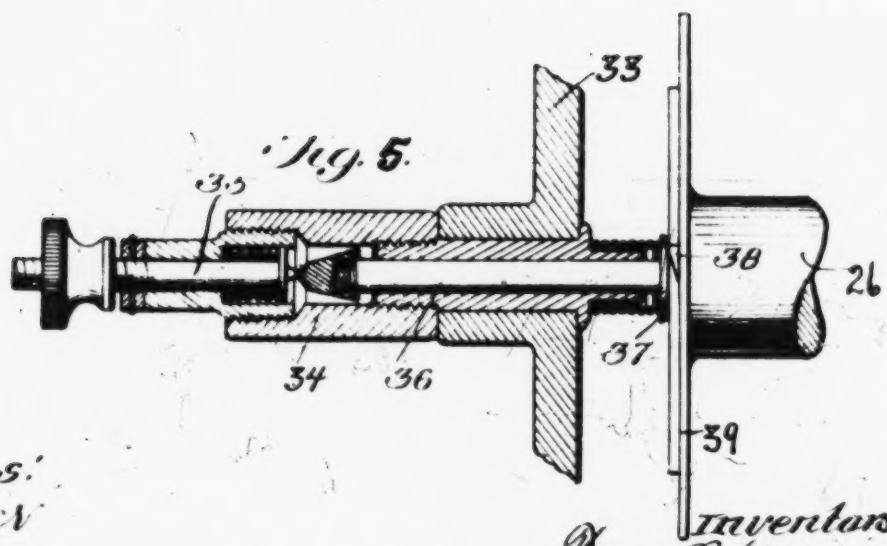


Fig. 5.



Witnesses:
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C. M. Lemmy

Inventors.
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Thomas J. Sturtevant,
by Atty Calver Atty.

No. 740,781. PATENTED OCT. 6, 1903.

T. L. & T. J. STURTEVANT.

ELECTRICAL SPARKING IGNITER FOR GAS ENGINES.

APPLICATION FILED OCT. 9 1901.

NO MODEL. 5 SHEETS—SHEET 5.

Fig. 6.

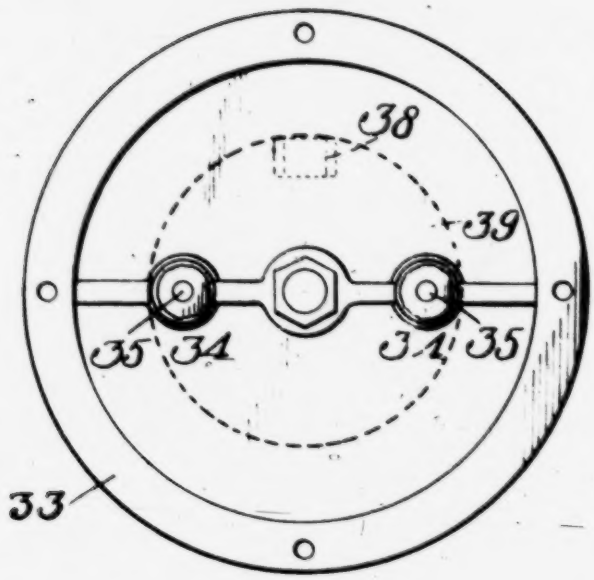
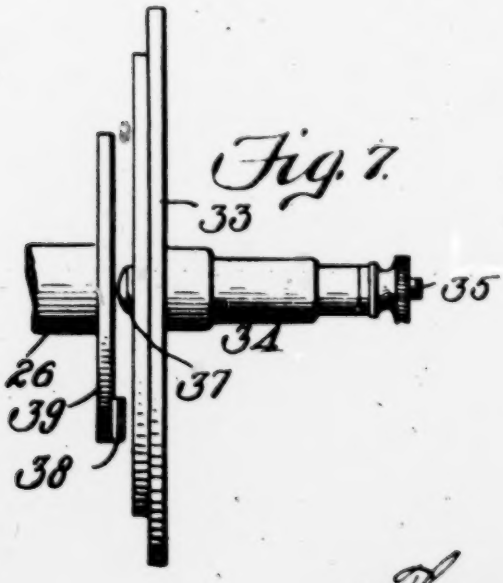


Fig. 7.



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C. D. Keisler.
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Inventors
Thomas L. Sturtevant,
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No. 740,781. Patented October 6, 1903.

UNITED STATES PATENT OFFICE.

THOMAS L. STURTEVANT, OF QUINCY, AND THOMAS J. STURTEVANT, OF NEWTON CENTER, MASSACHUSETTS.

ELECTRICAL SPARKING IGNITER FOR GAS-ENGINES.

SPECIFICATION forming part of Letters Patent No. 740,781, dated October 6, 1903.

Application filed October 9, 1901. Serial No. 78,083. (No model.)

To all whom it may concern:

Be it known that we, THOMAS L. STURTEVANT, residing at Quincy, in the county of Norfolk, and THOMAS J. STURTEVANT, residing at Newton Center, in the county of Middlesex, State of Massachusetts, citizens of the United States, have invented certain new and useful Improvements in Electrical Sparking Igniters for Gas-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

Our invention relates to that class of gas or explosion engines more particularly intended for use for driving motor-vehicles or boats, the object of our invention being to provide a balanced gas-engine of comparatively simple construction which will work smoothly or with as little vibration as possible and which is so constructed that the working parts most likely to require attention will be conveniently accessible for adjustment or repairs.

In the accompanying drawings, Figure 1 is a side view of our improved engine with the side covering-plate of the main casing removed to show the governor for the sparking devices. Fig. 2 is a plan view of the engine, partly in horizontal section. Fig. 3 is a side view of the same, partly in vertical section. Fig. 4 is a transverse sectional view on line 4 4, Fig. 3, through the cylinder and valve chamber. Fig. 5 is a detail view of a part of the sparking mechanism. Fig. 6 is a face view of the cover-plate with the make-and-break sparking plugs mounted thereon and with the cam-disk for operating the same shown behind in dotted lines, and Fig. 7 is a side view showing the same parts.

Referring to the drawings, 12 denotes the main casing of the engine, in which is mounted in suitable bearings the main crank-shaft, comprising the bearing or end portions 13, the outside disks 14, and the intermediate offset disk 15, the cranks 16 being connected to the said outside and intermediate disks. By forming the intermediate disk or web 15 with offset portions, as shown, we are enabled to bring the cylinders 17 more nearly opposite each other than would otherwise be possible and still permit the cranks to be sufficiently long as to afford adequate bearing-surfaces. In other words, the offset or intermediate disk or web 15 permits of the use of relatively long cranks in a comparatively compact space and enables the cylinders of the engine to be arranged nearly opposite each other. The cranks 16 are joined to the pistons 19 within the cylinders 17 by connecting-rods 20.

The main casing 12 is constructed at its lower part to form an oil-chamber 23, which will be supplied with oil, as denoted in dotted lines in Fig. 3. The main crank-shaft is provided with a gear-wheel 24, meshing with a larger gear-wheel 25 on a shaft 26 and which gear-wheel 25 is of proper size to dip into the oil in the oil-chamber 23. This gear-wheel 25 serves as a splasher for oiling the interiors of the cylinders and also for oiling the cranks and other running parts within the main casing, and it is so arranged as not to be directly opposite the chambers of either of the cylinders, so that it will not throw oil directly into the chambers of the cylinders; but by splashing it about generally in the chamber of the main casing the oil will naturally work its way into the parts to be lubricated, but without flooding the said parts with oil. We thus avoid an objection which sometimes arises from an excess of oil in the cylinders, in which case the oil works past the pistons into the combustion-chambers and by burning therein causes smoke and soot, which clogs up the parts and is thus seriously objectionable.

The shaft 26 is provided with cams 27 for operating the spring-pressed valve-rods 28, carrying the valves 29, controlling the openings to the sparking chambers 30, into which the sparking devices or plugs 11 extend. The chambers 30 are preferably provided with removable plugs 31, closing openings through which the valves may be removed, and also with plugs 32, through which when the said plugs 32 are removed the sparking can be observed.

The oil-chamber portion of the main casing is closed by the removable cover or plate 33, in which are mounted the make-and-break plugs 34, forming part of the sparking or igniting mechanism, and which plugs have suitable electrical connections with the sparking plugs 11, so that the electric circuits can be closed and opened at the proper times. These

make-and-break plugs each comprise a spring-pressed anvil rod or portion 35 and a spring-pressed hammer rod or portion 36. The hammer-rods 36 of the make-and-break plugs extend inward and are provided with small disks or caps 37, arranged in the path of movement of a cam 38, carried by a ring or disk 39, mounted on the shaft 26 and connected with the gear-wheel 25, so as to rotate therewith, excepting as its movements are controlled by a governing device to be described presently.

The cam 38 on the disk 39 is so arranged that when it strikes the caps 37 on the hammer-rods of the make-and-break plugs it will give slight turning movements to the said hammer-rods by reason of the side contact of the said cam with the said caps, so that the cam not only forces the hammer portions of said plugs inward into contact with the elastically-mounted anvil portions thereof, but owing to the slight rotary or twisting movements imparted to the hammer-rods both the hammer and anvil surfaces are kept clean by the rubbing contact incidental to the twisting movements imparted to the hammer-rods. This is important owing to the fact that the contact-surfaces by thus being kept clean will insure a proper sparking, while the elastically-mounted anvil-rods prevent any injurious contacts from resulting from the impacts of these make-and-break parts of the sparking devices.

The removable cover or plate 33 is central with the shaft 26, carrying the wheel 25, the valve-cams, and the sparking-governing devices, so that by removing said cover or plate easy access is afforded to these parts, which may be removed, if desired, through the opening closed by this cover or plate.

The governing device for the sparking mechanism comprises the levers 40, mounted on pivots 41 on the gear-wheel 25 and provided with weights 42. The outer ends of the levers 40 are drawn inward toward the center of the gear-wheel by springs 43, surrounding rods 44, jointed to the outer ends of the levers 40, said springs being partly housed in the cylinders 45, carried by the said gear-wheel. When the rotation of the gear-wheel is sufficiently rapid, so that the stress of the springs is overcome by the centrifugal action of the weighted levers, the cam-disk will be turned somewhat in the direction of the arrow, Fig. 1, through the links 46 connecting the levers 40 with the said disk, and when the speed of rotation of the said gear-wheel is lessened the said cam-disk will be moved in a reverse direction by the action of the said springs. Thus the cam 38 on the said cam-disk 39 will be moved forward or backward relative to the gear-wheel 25 for the purpose of varying the timing of the sparking in the combustion-chambers of the engine, as it is desirable in varying the speed of the engine, the time of sparking being earlier as the engine runs faster.

The cylinders of the engine are provided with double walls, forming between them spaces or chambers 47 for the circulation of water to cool the said cylinders, said chambers being provided with inlet-pipes 48 and outlet-pipes 49. A proper circulation of water through these chambers or water-jackets for the purpose of cooling the cylinders may be maintained by pumps in the usual manner.

From the foregoing it will be apparent that we provide a balanced gas-engine of compact arrangement so as to be well adapted for driving a motor-vehicle or boat with the least possible jar or vibration, and our engine is also constructed in such a manner that the cylinders and other interior parts will be well lubricated without being flooded with oil. Also the contact portions of the make-and-break plugs of the sparking device will be kept clean and bright by the slight rotary movements imparted to the hammer-rods thereof, and the parts of the engine to which frequent access may be desirable is provided for by the removable plugs 31 and 32 and the removable cover 33.

Having thus described our invention, we claim and desire to secure by Letters Patent—

1. In an explosion-engine, the combination with a sparking device in the combustion-chamber of the engine, of a make-and-break plug comprising a spring-pressed and endwise-movable anvil-rod and a spring-pressed and endwise-movable hammer-rod, and means for causing said rods to be forced into contact at suitable intervals.

2. In an explosion-engine, the combination with a sparking device in the combustion-chamber of the engine, of a make-and-break plug comprising an elastically-mounted anvil rod or portion and an elastically-mounted hammer rod or portion, and means for causing the said portions of the make-and-break plug to be forced into contact at suitable intervals, the said hammer-rod being provided with a cap or portion adapted to be engaged by said means in such a manner as to impart partial rotary movements to said hammer-rod at each contact of the said cam with the said cap.

3. In an explosion-engine, the combination with a sparking device located in the combustion-chamber of the engine, of a make-and-break device comprising two endwise-separable parts, means for forcing said separable parts into contact with each other at intervals, and means for imparting partial rotary movements, constantly in the same direction, to one of said separable parts as they are forced into endwise contact with each other.

4. In an explosion-engine, the combination with a sparking device located in the combustion-chamber of the engine, of a make-and-break plug comprising an elastically-mounted and endwise-movable anvil-rod and an elastically-mounted and endwise-movable hammer-rod, a cam for forcing one of said rods into contact with the other, at intervals, and

an automatic governor for regulating the timing position of said cam as the engine runs faster or slower.

5. In an explosion-engine, the combination with the main casing thereof provided with an opening, of an actuating-cam for the sparking device and an automatic regulator for the said cam both arranged opposite said opening and removable therethrough when the opening is not closed, a removable plate or cover closing the said opening and on which removable plate or cover the make-and-break plugs are mounted.

In testimony whereof we affix our signatures in presence of two witnesses.

THOMAS L. STURTEVANT.
THOMAS J. STURTEVANT.

Witnesses:
L. H. STURTEVANT,
W. H. ELLIS.

No. 780,221 PATENTED JAN. 17, 1905.

J. W. PACKARD.

ELECTRIC IGNITER.

APPLICATION FILED JAN. 10, 1903

2 SHEETS SHEET 1.

Fig. 2.

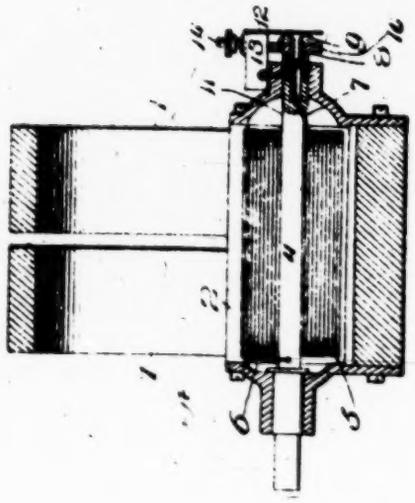


Fig. 3.

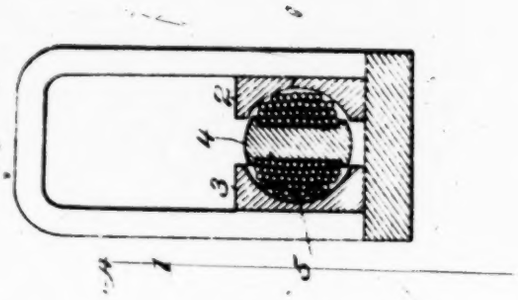
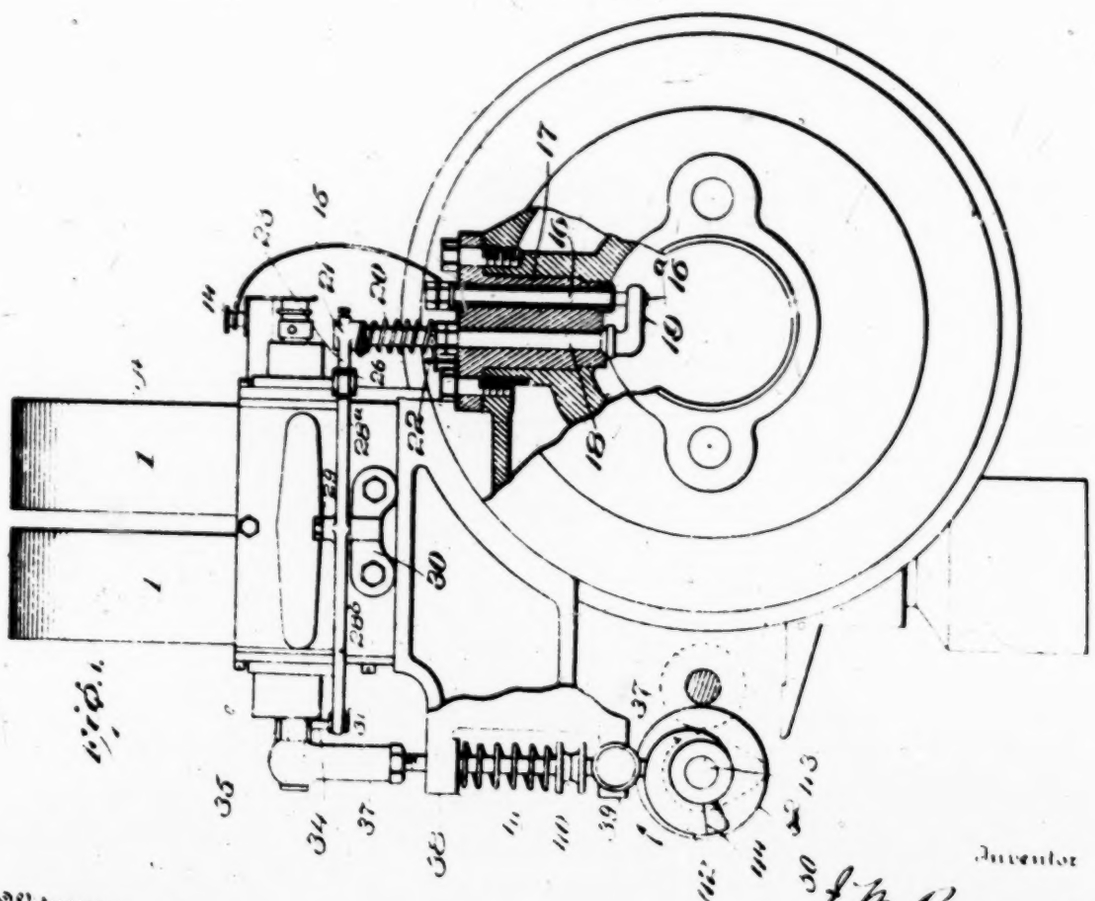


Fig. 1.



Witnesses
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C. W. Clement

Inventor
J. W. Packard
By Watson & Coatsworth
Attorneys

No. 780,221. PATENTED JAN. 17, 190

J. W. PACKARD.

ELECTRIC IGNITER.

APPLICATION FILED JAN. 10 190

2 SHEETS SHEET 1

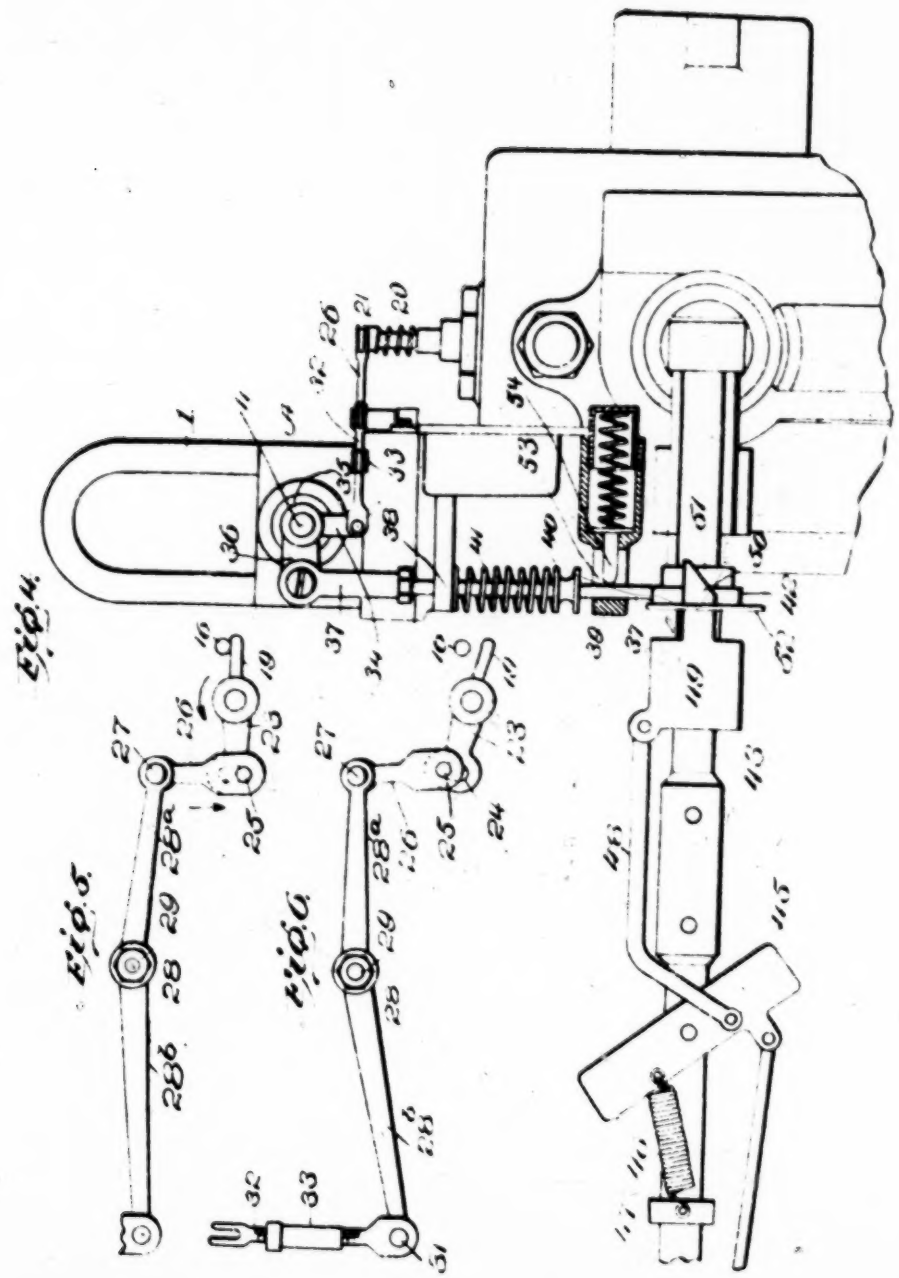

Fig. 4.

Fig. 5.

Fig. 6.

Witnesses
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C. W. Clement

Inventor
J. W. Packard
by Watson & Coleman
Attorneys

No. 780,221. Patented January 17, 1905.

UNITED STATES PATENT OFFICE.

JAMES W. PACKARD, OF WARREN, OHIO, ASSIGNOR TO THE PACKARD MOTOR CAR COMPANY, OF DETROIT, MICHIGAN, A CORPORATION OF WEST VIRGINIA.

ELECTRIC IGNITER.

SPECIFICATION forming part of Letters Patent No. 780,221, dated January 17, 1905.

Application filed January 10, 1903. Serial No. 138,501.

To all whom it may concern:

Be it known that I, JAMES W. PACKARD, a citizen of the United States, residing at Warren, in the county of Trumbull, State of Ohio, have invented certain new and useful Improvements in Electric Igniters, of which the following is a specification.

This invention comprises improvements in electric igniters for explosive-engines; and it includes an electric generator, means for intermittently operating said generator, means for separating the electrodes of the sparking device while the generator is in operation, and means for automatically varying the time of operation, and consequently of ignition, relative to the engine-stroke according to the speed of the engine.

In the accompanying drawings, Figure 1 is a rear end view of a gas-engine cylinder, partly in section, with the igniting apparatus applied thereto. Fig. 2 is a vertical longitudinal section through the center of the generator. Fig. 3 is a central transverse section through the same. Fig. 4 is a side view of the rear end of the cylinder with the igniting apparatus applied thereto and showing also the governor for controlling the time of ignition. Fig. 5 is a plan view of the levers for operating the movable electrode, said levers being shown in their normal position; and Fig. 6 is a similar view illustrating the manner in which the electrodes are separated when the current is being generated.

Referring to the drawings, A indicates an electric generator, preferably a magneto-generator, consisting of one or more permanent horseshoe-magnets 1, having internal pole-pieces 2 and 3, between which is arranged an H-armature 4, having insulated copper wire 5 coiled thereon. One end, 6, of the coil of wire is grounded upon the shaft, as shown in Fig. 2, and the opposite end, 7, is connected to a shank 8 upon a metal contact-disk 9. This shank extends into a tubular insulating-bushing 10, which fits into a socket in the end of the armature-shaft 11. A spring contact-arm or brush 12, secured upon an insulating-block 13, bears upon the contact-disk 9 and conducts the current to a binding-post 14 upon said block. A wire 15 connects the binding-post 14 with a stationary electrode 16, secured within and insulated from an igniter-plug 17. The conducting-wire 15 is the only necessary wire external to the generator. The end 6 of the generating-coil is electrically connected, through the generator and engine-frames and the various metal parts of the apparatus, with a movable electrode 18, which is capable of oscillation about its vertical axis and is provided at its lower end with the contact-arm 19, which latter is normally held against the lower end 16ª of the stationary electrode by a spiral spring 20, which is coiled about the upper end of the movable electrode. The upper end of this spring is connected to a collar 21, which is secured upon the movable electrode, and the lower end of the spring is connected to a fixed pin 22, which is secured to the igniter-plug. The spring tends to turn the movable electrode in the direction indicated by the arrow, Fig. 5, and normally presses the contact-arm 19 of said electrode against the stationary electrode, as shown in said figure and also in Fig. 1. Connected with the collar or hub 21 is a short lever-arm 23, having a slot 24 at its outer end, into which extends a pin 25 upon a link 26, which link is connected by a pivot-pin to one arm, 28ª, of a lever 28. This lever is mounted upon a pivot-pin 29, which is supported by a bracket 30 at the rear of the generator, and the longer arm, 28ᵇ, of the lever is connected by a pivot-pin 31 to a link 32, which is adjustable in length by means of a turnbuckle 33. The link 32 is connected to one arm, 34, of a bell-crank lever 35, which latter is secured upon the armature-shaft 11. The other arm, 36, of said bell-crank lever is pivotally connected to a rod 37, which is movable vertically in bearings 38 and 39. Between said bearings is arranged a collar 40, and between said collar and the bearing 38 is a compression-spring 41, which normally tends to force the rod 37 downwardly against a cam 42, which is secured upon a horizontal shaft 43. As shown in Fig. 1, the radius of the cam, starting near the shaft, gradually increases and the cam terminates abruptly at its highest point 44. Arranged upon the shaft 43 is a governor 45

consisting of a block or bar of metal pivoted centrally to the shaft. The centrifugal force when the shaft is in motion tends to throw the metal block or bar at right angles to the shaft against the tension of a spring 46, which is connected to the bar 45 at one side of its pivot-point and to a collar 47. A link 48 is connected to the bar 45 at the opposite side of its pivotal point, and this link is pivotally connected with a collar 49, movable longitudinally of the shaft and having a part 50, which projects longitudinally of the shaft in front of the abruptly-terminating end of the cam. The outer surface of the part 50, as shown in Fig. 1, is flush with the periphery of the cam, and said part forms a continuation of the cam. The rear face 51 of the projection 50 is beveled, as shown in Fig. 4, and it will be apparent that as the part 50 forms a continuation of the cam the position of said part will determine the time in the revolution of the shaft 43 when the rod 37 will drop from the higher onto the lower part of the cam. The projection 50 extends through a suitable guide-opening in a flange 52 at the side of the cam.

The shaft 43 is suitably geared to the engine and makes one revolution during each cycle of operations. The rotation of the cam raises the rod 37 slowly, and this rod in turn rocks the bell-crank lever 35, thereby moving the armature at a comparatively slow speed in one direction. At the same time the link 32 is drawn to the left in Fig. 4, thereby moving the lever 28 and forcing the link 26 in the direction indicated by the arrow, Fig. 5. This movement of the link 26 is not accompanied by a movement of the lever-arm 23 on account of the slot 24 in the link, which allows relative movement between said parts. The electrodes therefore are held in contact by the spring 20 during this movement of the parts. At the proper moment for the ignition of the charge in the engine-cylinder the rod 31 passes off of the elevated portion of the cam and is quickly depressed by the spring 41. The armature is thereby given a quick oscillation and an electric current is generated in its coils, the circuit being at the same time closed through the electrodes. While this current is being generated the electrodes are separated by the reverse movements of the link 32, lever 28, link 26, and lever 23. The movement of the lever 23 and the electrode does not take place until after the armature is in motion, so that a current of full intensity is generated before the electrodes are separated. The lost motion between the link 26 and lever 23, it will be seen, delays the separation of the electrodes, as the lever 23 will not be moved by the link until the pin 25 travels from one end of the slot to the other. Fig. 6 shows the relative positions of the parts at the time when the electrodes are separated to cause a spark.

The time of ignition is regulated according to the speed of the engine by the adjustable portion 50 of the cam, the position of which is controlled by the centrifugal governor. When the engine is operating slowly, the entire width of the part 50 will pass under the rod 37, and as this movable part of the cam is drawn to the left in Fig. 4 with an increase in speed it will be seen that the cam-surface will be shortened, thus permitting the rod 37 to drop at an earlier point in the revolution of the engine. The time of ignition is thus automatically controlled. I do not wish to confine myself to any particular form of generator or to any particular arrangement of levers and parts for operating the generator and separating the electrodes, as it will be evident that the parts may be variously constructed and arranged to accomplish the desired ends.

It will be evident that if it is desired to employ a jump-spark instead of a spark caused by separating the electrodes, the generator may be used to operate an induction-coil having its secondary winding connected to two separate electrodes in the combustion-chamber in the usual manner. Instead of operating the rod, which is tripped by the cam, with a spring, the said rod or member may be operated by a weight, which for all practical purposes is the equivalent of a spring.

The bearing 39 has a slot 53, through which the tripping-rod 37 extends, and the rod is normally held in position upon the cam-surface by a spring-pressed pin 54. In case of the reversal of the engine at any time the tripping-rod instead of being caught and bent or broken by the cam extension 50 will be moved laterally against the pressure of the pin 54 by the inclined face 51 of the cam extension.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is

1. In an electric igniter for explosive-engines, a generator, a spiral cam having a transversely-adjustable extension at its rear end, said extension having one end inclined to the axis of the cam, and a spring-pressed member bearing upon said cam and operatively connected to the movable member of the generator.

2. In an electric igniter for explosive-engines, a generator, a spiral cam having a transversely-adjustable extension at its rear end, said extension having one end inclined to the axis of the cam, and a governor arranged to vary the position of said cam extension according to the speed of the engine.

3. In an electric igniter for explosive-engines, a generator, a cam-shaft, a spiral cam upon said shaft, a collar movable longitudinally upon the shaft and having a part projecting longitudinally of the shaft and forming an extension of the cam-surface, the end

of said part being inclined to the axis of the shaft, a centrifugal governor connected to said collar, and a spring-pressed member connected to the movable member of the generator and bearing upon said cam.

4. In an electric igniter for explosive-engines, a fixed electrode, an electrode movable about its axis and having an arm arranged to bear against the fixed electrode, a spring normally holding said electrodes in contact with one another, a generator having coils connected to said electrodes, a cam, a spring-pressed member arranged to be tripped periodically by said cam, a bell-crank lever connected with the movable element of the generator and having one arm connected to said member, a centrally-pivoted lever connected to the other arm of said bell-crank lever, a link pivoted to said arm, said link having a pin at its outer end, and a lever-arm connected with the movable electrode and having a slot engaged by said pin.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES W. PACKARD.

Witnesses:

EDITH GORTON,

G. B. PORT.

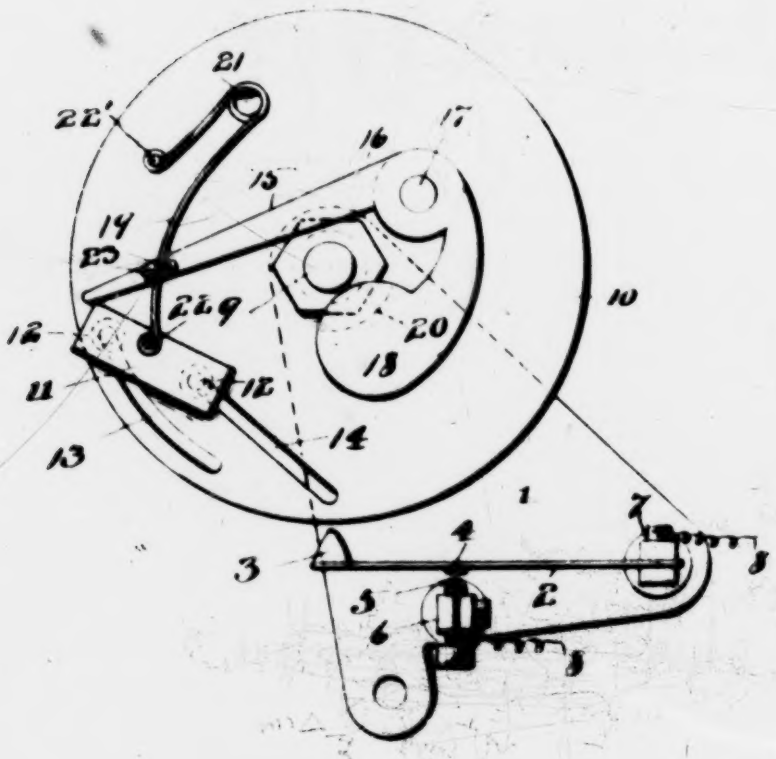
No. 798,992. PATENTED SEPT. 5, 1905.

W. J. COCHRAN.

CONTACT BREAKER FOR SPARKERS.

APPLICATION FILED MAR. 1, 1905.

Fig. 1.



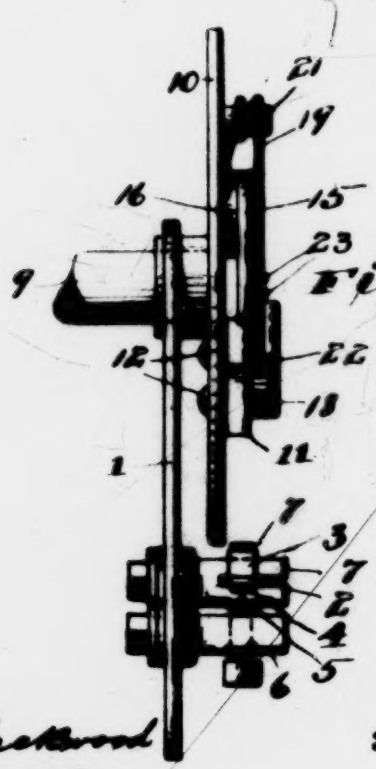


Fig. 2.

Witnesses:
Jas. H. Blackwood
Warren S. Ogden

Inventor
Walter J. Cochran
By
Attorneys

UNITED STATES PATENT OFFICE.

WALTER J. COCHRAN, OF CLEVELAND, OHIO, ASSIGNOR OF ONE-HALF TO HERBERT C. HEARNE, OF CLEVELAND, OHIO.

CONTACT-BREAKER FOR SPARKERS.

No. 798,992. Specification of Letters Patent. Patented Sept. 5, 1905.

Application filed March 1, 1904. Serial No. 196,042.

To all whom it may concern:

Be it known that I, WALTER J. COCHRAN, a citizen of the United States of America, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Contact-Breakers for Sparkers; and I hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it pertains to make and use the same.

My invention relates to contact-breakers for explosive-engine sparkers; and its object is to provide means of a simple and effective character for automatically advancing or retarding the time of ignition of the explosive charge in accordance with and automatically governed by changes in the speed of the engine.

To this end my invention is embodied in its preferable form in the device hereinafter described, and illustrated in the drawings herewith.

In the accompanying drawings, Figure 1 is a front view in elevation of the device embodying my invention, and Fig. 2 is a side or edge view in elevation.

Referring to the drawings, 1 is a plate or bracket which may be secured to the frame of the motor or of the vehicle if the engine is applied to the latter. On this plate is mounted a spring contact-finger 2, carrying at its free end a toe-piece 3. A contact-piece 4 is carried by the finger between its ends and is adapted to make electrical contact with a pin or other contact member 5, carried by a binding-stud 6, which is mounted on the plate 1. The stud 6 and another binding stud or screw 7, the latter being adapted to receive the end of the spring contact member 2, are adapted to be connected by wires 8 to a suitable jump-spark device (not shown) in the engine-cylinder.

Fixed on a shaft 9, which may be the main shaft or another shaft connected thereto in the proper ratio of revolution according to the number of cycles of the engine, is a rotatable contact-maker carrier consisting, preferably, of a disk 10. On this disk is mounted a contact-maker consisting of a wiper-block 11, having a portion extending outside the periphery of the disk and adapted to wipe against the toe 3 of the spring contact-piece 2, which toe-piece is located in the line of travel of the projecting part of the block. The block is slidably mounted, by means of screw-bolts 12, in guide-slots 13 14 in the disk. The slot 13 is a circumferential slot, and slot 14 extends on a secant to the circle of the disk, whereby as the block moves back and forth on the disk it will maintain the same extent of projection beyond the edge of the disk. Adapted to bear against the rear end of the block is a lever 15 of a centrifugal governor 16, pivoted on the disk at 17 and carrying a weight 18. The weight may be cut away or offset at 20 to pass over the nut on the end of the shaft 9. A coiled and bent spring 19 is connected at one end to the wiper-block 11, being twisted around a pin 22 on the block, and is coiled around a stud 21 and at the other end connected to a pin 22′ on the disk. This spring serves to pull the block to the rear end of the slots 13 14 and to hold it normally retracted at the rear ends of such slots. Guide-pins 23 are mounted on the lever 15 on each side of the spring 19.

The operation of the device is as follows: Should the speed of the engine be increased, the speed of rotation of the shaft 9 will be correspondingly increased, and if the speed is sufficiently great the governor-weight 18 will be thrown outward away from the center of the disk, causing the governor to turn on its pivot, and in consequence of this movement the lever 15 will press the wiper-block 11 forward in its guide-slots in the direction of movement of the disk and move the block around on the disk, and thereby advance the time of contact and the time of ignition. The wiper-block in its travel will wipe against the projecting toe-piece 3 of the spring-contact 2 and press the contact-piece against the pin contact member 5, thereby establishing a circuit and exciting the sparker in the engine-cylinder. When the speed decreases, the governor will move inward and the block will be drawn back by the spring 19. When the block is advanced owing to the pivoting of the governor, it will yield somewhat when it strikes the toe-piece of the contact member and the block will drag slightly. Hence a proportionately longer period of contact will be obtained when the engine is running at higher speeds, thereby further insuring the certainty of the ignition. The diameter of the circle the contact-maker travels in being so great in proportion to the size of the contact-maker, the life of the batteries is lengthened over

that under the operation of the ordinary sparker.

The number of contact-makers corresponds to the number of cylinders employed.

It is clear that changes may be made in the details of the device without departing from the principle of my invention.

Having thus described my invention, what I claim is

1. A contact make and break device for engine-sparkers having circuit-closing contact-pieces, a rotatable carrier, a wiper-block mounted on said carrier and projecting into the line of one of said contacts, means to permit said wiper-block to slide circumferentially on the carrier and a centrifugal governor and a spring on said carrier for controlling the sliding of the block, substantially as described.

2. A make and break device for engine-sparkers having circuit-closing contact-pieces, in combination with a rotatable disk driven from the engine, a contact-maker consisting of a wiper-block carried by said disk, one of said contact-pieces projecting into the line of travel of said block and meeting the same at an angle, and means to permit said block to slide on said disk, substantially as described.

In testimony whereof I sign the foregoing specification, in the presence of two witnesses, this 26th day of February, 1904, at Cleveland, Ohio.

WALTER J. COCHRAN.

Witnesses:
HENRY I. EMERSON,
WALLACE I. KNIGHT.

No. 810,963. PATENTED JAN. 30, 1906

H. N. MOTSINGER.

ELECTRIC IGNITER.

APPLICATION FILED MAY 31, 1904.

2 SHEETS—SHEET 1.

Fig. 2.

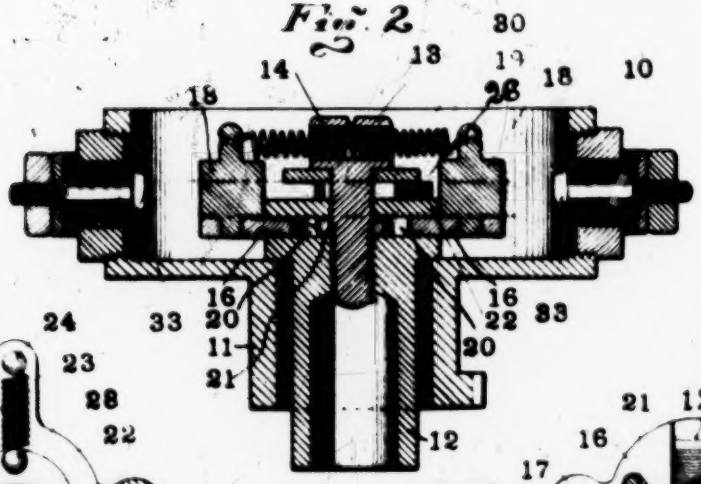


Fig. 3.

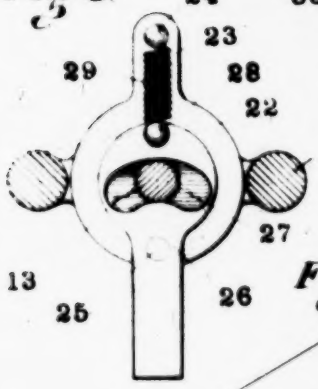


Fig. 4.

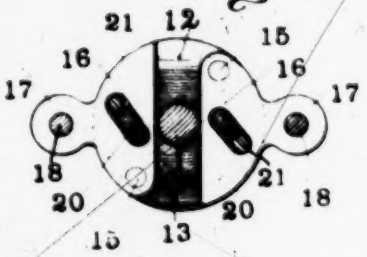
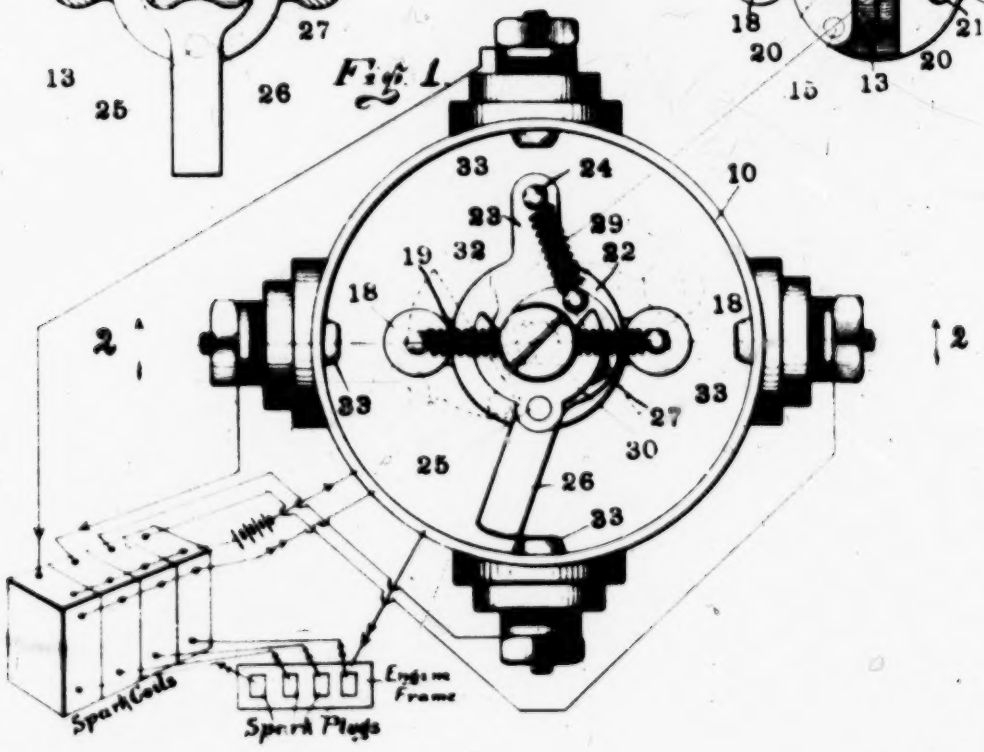


Fig. 1.



Witnesses
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Attorneys

No. 810,963. PATENTED JAN. 30, 1906

H. N. MOTSINGER.

ELECTRIC IGNITER.

APPLICATION FILED MAY 31, 1904.

2 SHEETS SHEET 2

Fig. 6.

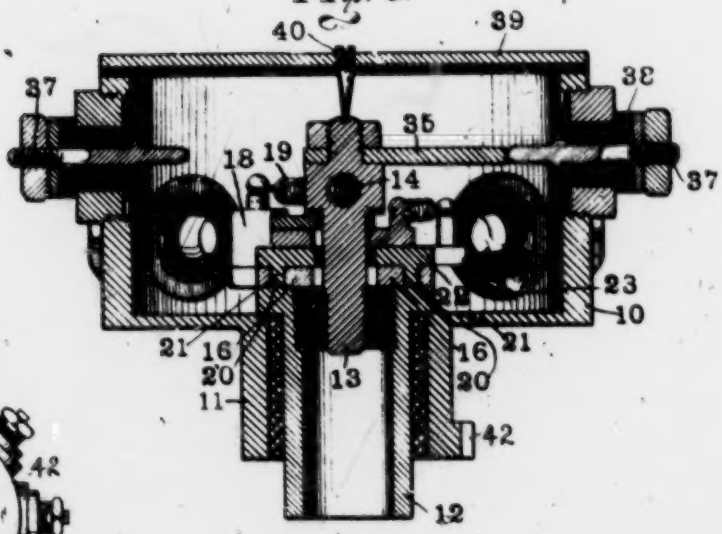


Fig. 7.

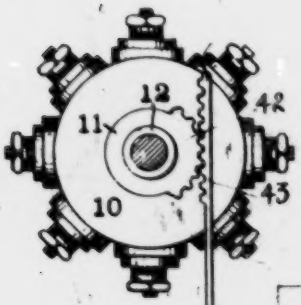
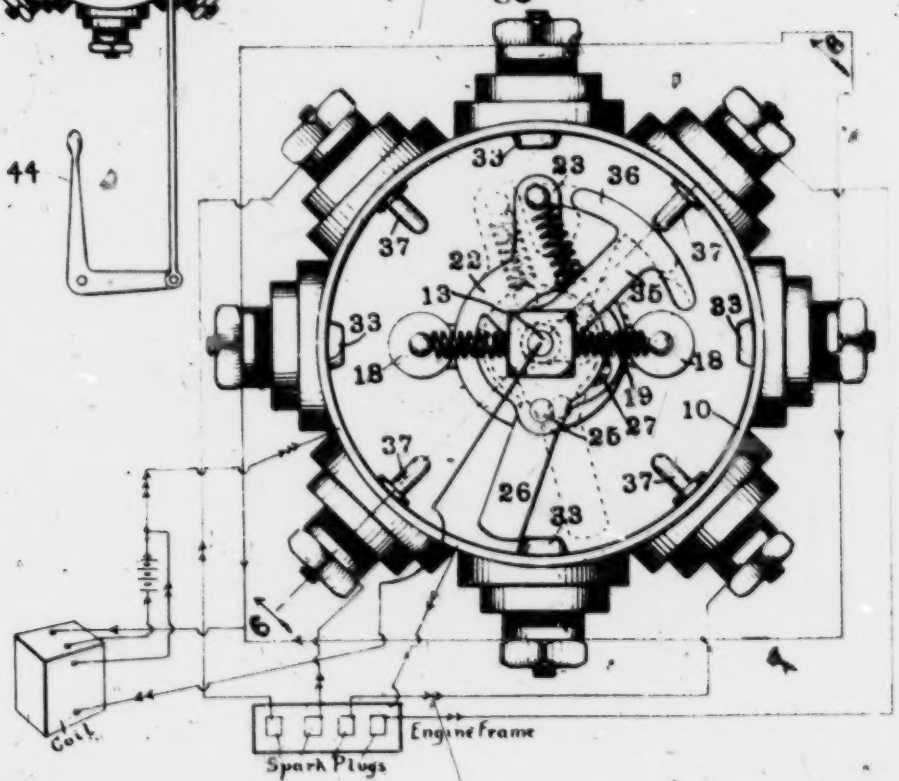


Fig. 5.



Witnesses
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J. A. Walsh.

Inventor
Homer N. Motsinger.

By
Bradford Hood
Attorneys

UNITED STATES PATENT OFFICE.

HOMER N. MOTSINGER, OF PENDLETON, INDIANA, ASSIGNOR TO MOTSINGER DEVICE MANUFACTURING COMPANY, OF PENDLETON, INDIANA, A CORPORATION OF INDIANA.

ELECTRIC IGNITER.

No. 810,963. Specification of Letters Patent. Patented Jan. 30, 1906.

Application filed May 31, 1904. Serial No. 210,485.

To all whom it may concern:

Be it known that I, HOMER N. MOTSINGER, a citizen of the United States, residing at Pendleton, in the county of Madison and State of Indiana, have invented certain new and useful Improvements in Electric Igniters, of which the following is a specification.

The object of my invention is to produce a device for automatically controlling the terminals in an igniting system for gas-engines and to provide means by which the time of action may be externally and manually retarded or advanced without disturbing the adjustment of the governor.

The accompanying drawings illustrate my invention.

Figure 1 is a plan of a mechanism embodying my invention, together with a diagram of the wiring; Fig. 2, a section on line 2 2 of Fig. 1; Fig. 3, a section of Fig. 2 immediately beneath the plate 30; Fig. 4, a section of Fig. 2 immediately above arm 16; Fig. 5, a plan of a modified form for use in connection with a single-induction spark-coil for multiple cylinders, together with a diagram of the wiring; Fig. 6, a section on line 6 6 of Fig. 5, and Fig. 7 an under plan showing a means for manually advancing or retarding the time of terminal action.

In the drawings, 10 indicates a suitable inclosing casing having a central bearing 11 within which is journaled a short shaft-section 12, to which a driving-shaft may be attached. Secured to the inner end of shaft 12 is a pin 13, having a head provided with a transverse opening 14. The head of shaft 12 is slightly enlarged, as clearly shown in Fig. 2, and this head carries a pair of pins 15 15, which lie parallel with the axis of the shaft-section and are diametrically opposed. Pivoted upon each pin 15 is a governor-arm 16, each of which is provided with an extension 17, to which is attached a small governor-weight 18. A spring 19 extends through the transverse opening 14 and has its ends attached to governor-weights. Each governor-arm is provided with a slanting slot 20, adapted to receive a pin 21, projecting downward from the under face of a plate 22, sleeved upon the pin 13. Plate 22 is provided at one side with an extended arm 23, from which arises a pin 24. Opposite arm 23 the upper side of plate 22 is provided with a pin 25, upon which is pivoted a contact-arm 26, said contact-arm being provided with an arc-shaped slot 27, through which the pin 13 passes freely. Contact-arm 26 is provided with a pin 28, which lies adjacent pin 24 of plate 22, and these two pins are connected by a spring 29, which tends normally to hold the outer end of contact-arm 26 radially extended from the center of pin 13. Arranged above the contact-arm 26 is a plate 30, provided with an opening adapted to receive pin 25, said plate being provided with a perforation through which the pin 13 passes and having a portion cut away, as at 32, to permit freedom of movement of pin 28 about pin 25 as an axis. Projecting into the path of movement of the end of contact-arm 26 are contact-points 33, as many as may be desired, said contact-points being insulated from the contact-arm 26 in any desired manner. In the drawings these points 33 are shown as carried by insulating-plugs inserted in the main casing 10.

Where a single induction-coil is to be used with a multicylinder-engine, I use the construction shown in Figs. 5 and 6. The construction already described is the same, except that the pin 13 is insulated from the shaft 12, as is clearly shown in Fig. 6, and the following parts are added: A terminal arm 35 is secured to the upper end of pin 13 and is projected radially toward the wall of casing 10 and provided at its outer end with an extended arc-shaped portion 36, which covers, say, ten or fifteen degrees. This extension 36 is adapted to communicate the high-tension current successively to a series of terminals 37, which are carried by insulated supports 38, mounted in the wall of the casing, as clearly shown in Figs. 5 and 6. In either form the casing 10 will be provided with a suitable cover, the cover 39 of the second form (that shown in Figs. 5 and 6) being provided with a central pin 40, adapted to contact with the head of pin 13. Pin 40 should be insulated from the casing in the modification shown in Fig. 6.

Thus far the means for advancing or retarding the spark is entirely automatic; but

there are times when it is advisable that the operator be able to manually advance or retard the spark without, however, affecting the adjustment or operation of the automatic means, and for this purpose I provide suitable means for rotating the casing upon shaft 12. In the drawings I have shown a means in which the casing 10 is provided with a segmental gear 42, engaged by a rack-bar 43, (see Fig. 7,) connected by any suitable connections to an operating-lever or other operating means 44, the arrangement being such that by shifting the rack-bar 43 the casing 10 may itself be angularly shifted through a desired angle about the axis of rotation of the shaft 12.

In operation, referring especially to Figs. 1 and 2, suppose each of the terminals 33 to be connected with one primary terminal of one spark-coil, while shaft 12 (casing 10) is connected to the other side of the sparking-circuit in the usual manner, as indicated in Fig. 1. When shaft 12 is rotated, arm 26 will be brought successively into contact with the terminals 33, and because of the length of said arm the arm will be held at its outer end by each terminal, while the pivot 25 thereof will continue in regular motion. As a consequence the arm 26 is swung upon the pivot 25, as shown in Fig. 1, while the end thereof is held in contact with the terminal 33. When pin 25 has been carried around a sufficient distance, however, the terminal 33 no longer forms an obstruction to the arm 26, and the spring 29 thereupon operates to bring the arm 26 quickly away from the terminal. As the speed of shaft 12 increases the governor members 16 swing upon their pivots 15 and through the inclined slots 20 act upon the pins 21 of plate 22, and this causes the plate 22, together with the arm 26, carried thereby, to swing around pin 13 as an axis in the direction of rotation of shaft 12, thus advancing the time of contact of arm 26 with the terminal 33. In the construction shown in Figs. 5 and 6 the arm 26 is placed in the primary circuit, while the arm 35 36 is in the secondary circuit, the arrangement being such that the portion 36 comes in close proximity to one of the terminals 37 at the same time that arm 26 contacts with one of the terminals 33, the portion 36 of the arm 35 being made of the lengths shown in order to allow for the required amount of advancing or retracting of the arm 26 with relation to the shaft 12.

With the construction described and any given position of the governor members the spark will take place at a given point in the stroke of each piston. If the operator, however, desires a different time of spark at the same speed, he has merely to shift the rack-bar 42, and thus advance or retract the casing 10, whereupon the desired result is obtained.

I claim as my invention—

1. In an electric igniter, the combination of, a casing carrying one or more terminals projecting beyond the path of movement of a contact-arm, a shaft journaled in said casing, a plate rotatably mounted on the shaft, the said contact-arm pivoted upon said plate eccentrically with relation to the shaft and extending substantially radially to coöperate with the casing-terminals, yielding means for holding said arm in normal position, speed-controlled means carried by said shaft, and connections between said speed-controlled means and said plate whereby the plate will be angularly shifted by movement of the speed-controlled means.

2. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically to the axis of rotation and extending substantially radially, and the other of said terminals projecting into the path of movement of the radially-projecting terminal between its end and its pivotal point, and means for yieldingly holding said pivoted terminal in normal position with relation to its carrier.

3. In an electric igniter, the combination of, a casing carrying one or more terminals, a shaft journaled therein, a normally radially extending contact-arm pivotally mounted upon said shaft eccentrically thereto and adapted to coöperate with the casing-terminals, and means for yieldingly holding said contact-arm in normal position.

4. In an electric igniter, the combination of, a casing carrying one or more terminals, a shaft journaled in said casing, a plate rotatably mounted on the shaft, a contact-arm pivoted upon said plate eccentrically with relation to the shaft and extending substantially radially to engage the terminal, yielding means for holding said arm in normal position, speed-controlled means carried by the shaft, connections between said speed-controlled means and said plate whereby the plate will be angularly shifted by movement of the speed-controlled means, and means for shifting the casing angularly upon the shaft.

5. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other and the said other normally fixed, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and projecting substantially radially, and the other extended into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminals in normal position with relation to its carrier, and means for angularly adjusting the normally fixed member with relation to the rotating member.

6. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation, and extending substantially radially, and the other extended into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminal in normal position with relation to its carrier, and speed-controlled means operated by the rotatable member for shifting one of the contact-terminals angularly.

7. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other and the other normally fixed, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and extending substantially radially, and the other extended into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminal in normal position with relation to its carrier, speed-controlled means operated by the rotatable member for angularly shifting the terminal carried by said rotatable member, and means for angularly adjusting the normally fixed member and its terminal.

8. In an electric igniter, the combination of, a casing carrying one or more terminals, a shaft journaled therein, a plate rotatably mounted on the shaft, a substantially radial contact-arm pivoted upon said plate eccentrically with relation to the shaft and radially extending therefrom, yielding means for holding said arm in normal position and capable of permitting movement of the arm in either direction, and a pair of governor-arms eccentrically pivoted upon the shaft and each having an inclined slot engaging a portion of said plate whereby said governor members will operate to shift the plate angularly upon the shaft.

9. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and extending substantially radially, and the other of said members projected into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminal in normal position with relation to its carrier, and a second pair of contact-terminals carried by each of said members, said second pair being insulated from the first pair.

10. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other and the said other normally fixed, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and extending substantially radially, and the other of said members projected into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminals in normal position with relation to its carrier, speed-controlled means operated by the rotatable member for shifting one of the contact-terminals angularly, and a second pair of contact-terminals carried by said members and insulated from the first pair of contact-terminals.

11. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and extending substantially radially, and the other of said members projected into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminal in normal position with relation to its carrier, speed-controlled means operated by the rotatable member for shifting one of the contact-terminals angularly, and a second pair of contact-terminals carried by said members and insulated from the first pair of contact-terminals.

12. In an electric igniter, the combination of, a pair of members one rotatable with relation to the other and the other normally fixed, a pair of contact-terminals one carried by each of said members and one of said terminals being pivoted eccentrically with relation to the axis of rotation and extending substantially radially, and the other of said members projected into the path of movement of the pivoted member between its end and its pivotal point, means for yieldingly holding said pivoted terminal in normal position with relation to its carrier, speed-controlled means operated by the rotatable member, means for angularly adjusting the normally fixed member and its terminal, and a second pair of contact-terminals carried by said members and insulated from the first pair of contact-terminals.

13. In an electric igniter, the combination of, a casing carrying two sets of one or more terminals, a shaft journaled therein, a plate rotatably mounted on the shaft, a radially-extending contact-arm pivoted upon said plate eccentrically with relation to the shaft and adapted to coöperate with one set of casing-terminals, yielding means for holding said arm in normal position and permitting movement of the arm in either direction, a pair of governor-arms eccentrically pivoted upon the shaft and each having an inclined

P-44

slot engaging a portion of said plate whereby said governor members will operate to shift the plate angularly upon the shaft, and a second contact-arm carried by the shaft in position to coöperate with the other set of casing-terminals and insulated from the pivoted contact-arm.

In witness whereof I have hereunto set my hand and seal, at Indianapolis, Indiana, this 21st day of May, A. D. 1904.

HOMER N. MOTSINGER. [L. S.]

Witnesses:

ARTHUR M. HOOD,

JAMES A. WALSH.

No. 816,083. PATENTED MAR. 27, 1906.

F. O. FARWELL.

CURRENT CONTROLLER FOR IGNITING DEVICES FOR HYDROCARBON ENGINES.

APPLICATION FILED OCT. 21, 1904.

3 SHEETS—SHEET 1.

Fig. 1.

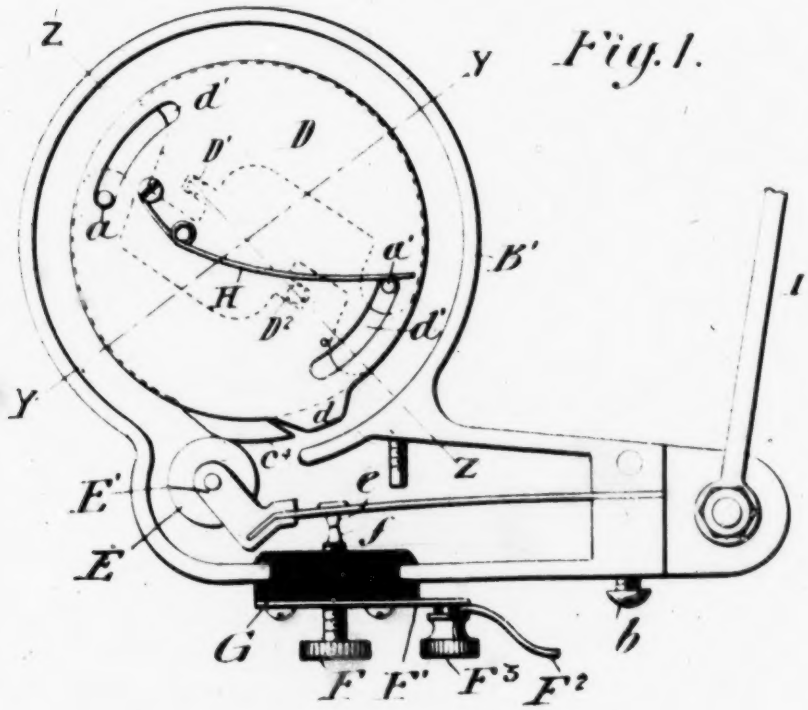
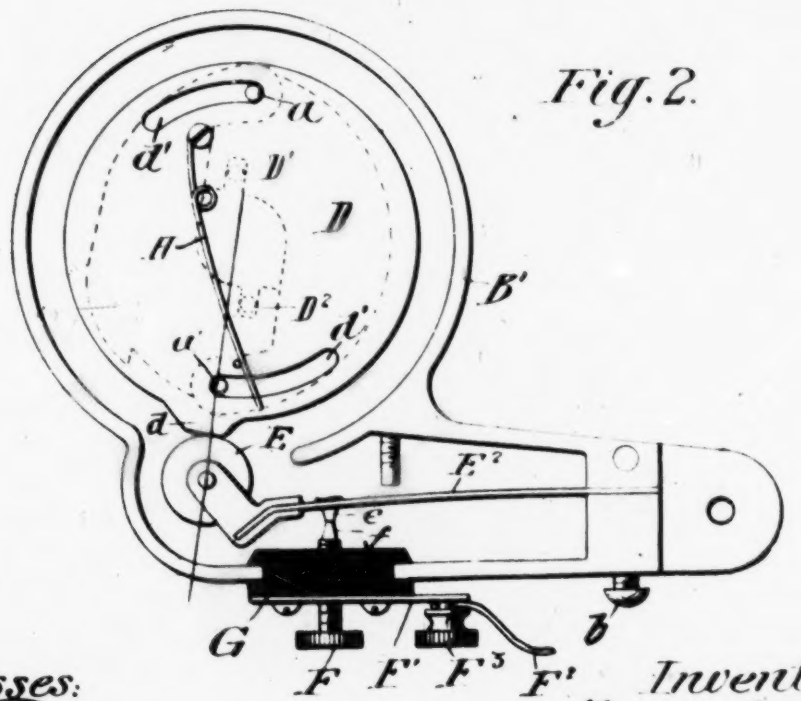


Fig. 2.



Witnesses:
O. O. Edelin.
Chas. J. O'Neill

Inventor:
Fay O. Farwell,
by Lemmo & Goldsborough,
Attys

No. 816,083. PATENTED MAR. 27, 1906.

F. O. FARWELL.

CURRENT CONTROLLER FOR IGNITING DEVICES FOR HYDROCARBON ENGINES.

APPLICATION FILED OCT. 21, 1904.

3 SHEETS—SHEET 2.

Fig. 3.

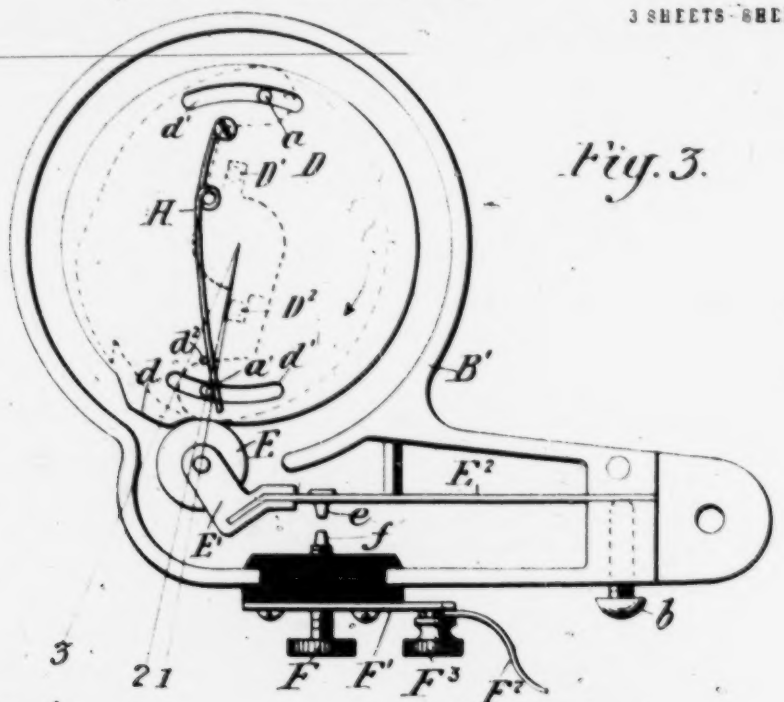


Fig. 4.

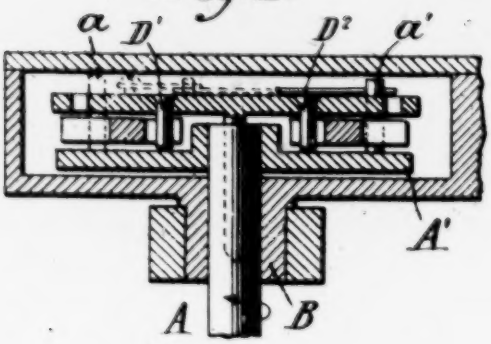


Fig. 5.

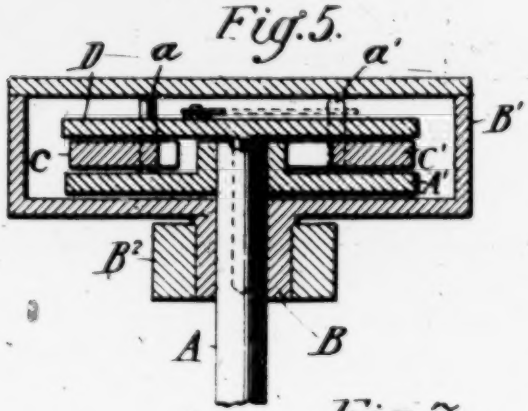


Fig. 6.

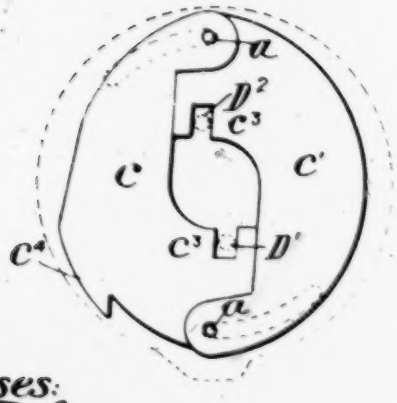
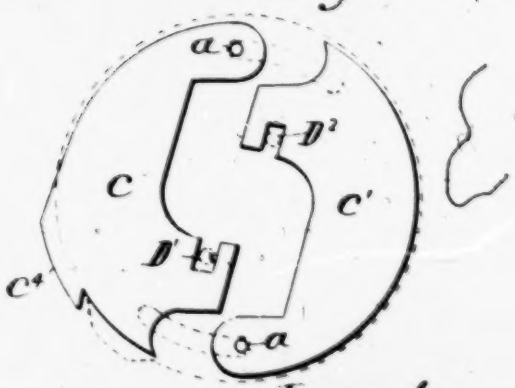


Fig. 7.



Witnesses:
D. W. Edlin.
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Inventor:
Fay O. Farwell,
by Dennis Goldsborough
Attys

No. 816,083. PATENTED MAR. 27, 1906.

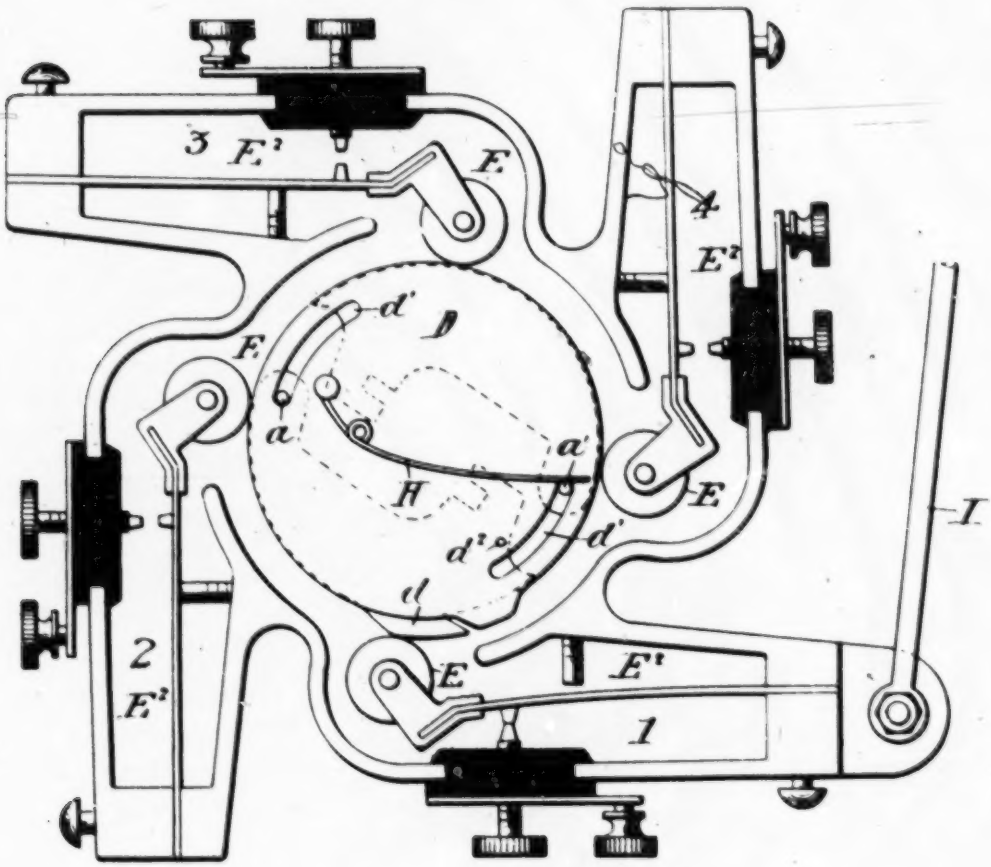
F. O. FARWELL.

CURRENT CONTROLLER FOR IGNITING DEVICES FOR HYDROCARBON ENGINES.

APPLICATION FILED OCT. 21, 1904.

3 SHEETS SHEET 3.

Fig. 8.



Witnesses
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Chas J. O'Neill

Inventor:
Fay O. Farwell,
by Fennie & Goldsborough,
Attys

UNITED STATES PATENT OFFICE.

FAY O. FARWELL, OF DUBUQUE, IOWA, ASSIGNOR OF ONE-HALF TO THE ADAMS COMPANY, OF DUBUQUE, IOWA, A CORPORATION OF IOWA.

CURRENT-CONTROLLER FOR IGNITING DEVICES FOR HYDROCARBON-ENGINES.

No. 816,083. Specification of Letters Patent. Patented March 27, 1906

Application filed October 21, 1904. Serial No. 229 415.

To all whom it may concern:

Be it known that I, FAY O. FARWELL, a citizen of the United States, residing at Dubuque, county of Dubuque, State of Iowa, have invented certain new and useful Improvements in Current-Controllers for Igniting Devices for Hydrocarbon-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to igniting devices for hydrocarbon-engines, and has for its object to provide a simple and efficient apparatus for automatically firing the explosive charge of a hydrocarbon-engine at the proper time when the speed of the engine varies, the device being so constructed and arranged that as the speed of the engine increases the length of time that contact is established will be commensurately increased and, furthermore, the contact will be broken sharply and abruptly irrespective of the speed of the engine, so as to insure sparks of equal intensity for all speeds.

It is well known that a hydrocarbon-engine develops the greatest efficiency when the explosion takes place immediately after the piston commences its upward stroke after having passed the dead-center on the compression-stroke. It is also well known that after the primary circuit of the spark has been closed it takes a certain time before the coil is sufficiently saturated to produce a spark and also that a certain additional time after the spark has passed in the cylinders is required before combustion takes place. These several periods of time, while actually very short, are nevertheless sufficient in the aggregate to allow the engine to turn a part of a revolution, greater or smaller, according to the speed of the engine, before the charge is completely exploded. It has been found, for instance, that when an engine is making a speed of one hundred revolutions per minute it will turn something like one thirty-sixth of a revolution after each contact before the explosion takes place, and if the engine were run at one thousand revolutions per minute it would make as much as one-sixth of a revolution after each contact before the corresponding explosion ensues. Therefore to get the best efficiency from a hydrocarbon-engine that is to be run at varying speeds the time of contact with respect to the revolution of the engine must be varied. In common practice this is done by hand. The present invention is designed to vary the contact of the primary circuit automatically. It is also common practice to make the contact long enough for the highest speed; but under these conditions it will be seen that when the engine is run slowly the contact would be maintained for a period much longer than necessary, and therefore entail a considerable waste of current. By regulating not only the time of contact, but the duration thereof, the present invention also serves to effect the greatest possible economy with respect to the battery-current.

In operating spark-coils without a vibrator effective operation is dependent upon a quick rapid separation of the contact-points to produce a spark. If the separation of the contacts is slow or gradual, a proper tension is not produced, and the spark is of little effect in firing the explosive charge. The present invention, in addition to the features above mentioned, contemplates the provision of means for producing a rapid separation of the contact-points, and consequently a fat or heavy spark even when the engine is turned very slowly, as in starting by hand.

Referring to the accompanying drawings, Figure 1 is a plan view of the device, showing the contact in position for the earliest and longest period. Fig. 2 is a similar view showing the contact in position for the latest and shortest period. Fig. 3 is a corresponding view with the contact broken. Fig. 4 is a section on line Y Y of Fig. 1. Fig. 5 is a section on line Z Z of Fig. 1. Fig. 6 is a plan view of the governor-weights in closed position. Fig. 7 is a corresponding view of the weights in expanded position. Fig. 8 is a plan view of a multiple igniting device of the same general character.

In the drawings, A is a driving-shaft or member which is connected by gearing or otherwise to the engine so that it may be rotated at the proper speed to produce the contact, as frequently desired. Secure on the upper end of the shaft A is a disk A′, upon which are mounted two driving-studs *a a′*. Surrounding the upper end of the shaft is the hub B of a casing B′, which surrounds and

incloses the entire mechanism. The said hub is preferably journaled in a bracket or support B^3, so that the entire casing may be conveniently revolved to set the apparatus for the proper position or time of spark.

Pivoted to the studs a a' are the governor-weights c c', which are adapted to swing upon their respective pivots from the position shown in Fig. 6 to that shown in Fig. 7.

Pivoted to the top of the shaft A is a cam-disk D, having two downwardly-projecting studs D′ and D^2 secured therein in such relation as to engage recesses c^3 c^3 in the governor-weights c c'. Extending from the periphery of the cam D is a short cam projection d, which is adapted to engage at one point of its revolution with a roller E, which is supported in a bracket E′, which in turn is mounted upon the end of a spring E^2, the other end of which is secured to the frame or casing B′ by means of a set-screw b. The tendency of the spring E^2 is to force the roller E into contact with the periphery of the disk D. Secured to the spring E′ is a contact-point e, forming one of the terminals of the primary circuit of the spark-coil. The coöperating point f is mounted in an adjusting-screw F, which passes through a brass conducting-strip F′, to which the conducting-wire F^2, forming a branch of the primary circuit, is secured by a thumb-nut F^3, the screw F being insulated from the frame B by means of a fiber or rubber block G.

The studs a a', upon which the governor-weights c c' are pivoted, are passed through segmental slots d' in the cam-disk D, and one of these studs is engaged by a spring H, which is secured to the top of the disk D and is adapted to hold the disk with some resistance from rotating faster than the shaft A. On the outer edge of the governor-weight c is a projection c^4, which when the weights are expanded, as shown in Figs. 1 and 7, increases or adds to the length of the cam d by an amount substantially commensurate with the speed of the engine, thereby holding the contact-points e and f together for a longer period than they would be held by the cam d alone. In the top of the cam-disk D is a pin d^3, placed in such position that when the spring H is in contact with it the end of said spring will be so held with respect to the slot d' that substantially one-fourth of the length of said slot may be traversed by the pin a a' before the latter comes in contact with the spring, the object of which construction will be hereinafter explained.

The operation of the device as above described is substantially as follows: The shaft A, and with it all of the rotatory parts, including the cam-disk D, are rotated in the direction indicated by the arrow. In starting a gas or gasolene engine it is usually turned by hand and the speed is very slow. Consequently disk D has a correspondingly-slow rotatory motion, and the cam d engages roller E and forces the latter, with its spring E^2, outward until contacts e and f are brought together. This condition is maintained while the short cam d lies under the roller E, and a line drawn through the centers of disk D and roller E would pass through the stud a', as shown in Fig. 2. A slight further movement of the disk D, however, would cause the roller E to begin to descend the side of the cam d, and the pressure of the spring E^2 would cause disk D and cam d to move quickly forward in the direction in which it is rotating—that is to say, the force of spring E^2 applied to the disk D would accelerate the movement of the latter beyond the normal speed imparted thereto from shaft A. For instance, referring to Fig. 3, if the distance which the shaft A rotates at the time of separation of the contacts be indicated by the angular distance between lines 1 and 2 the movement of the cam d would be represented by the angular distance between lines 1 and 3 for the same period of time. Thus the cam would be forced out from under the roller E by the action of spring E^2, and the contacts e f would be separated by a quick snappy action, which would of course produce a heavy spark. It will be seen, furthermore, that this quick separation of the contacts will take place independently of the speed of the engine, so that a practically uniform spark will be produced whether the engine be turning slowly or rapidly. As the speed of the engine increases centrifugal force will tend to throw the governor-weights c c' outward from the position shown in Fig. 6 to that in Fig. 7, thereby causing the cam-disk D and the cam d to be advanced in the direction of rotation and also causing the projection c^4 to extend beyond the periphery of the disk D, and thereby add its length to that of the cam d, causing the contact-points e and f not only to be brought into engagement at an earlier point in the revolution of the shaft A, but also causing them to remain in contact for a longer part of the revolution. When the speed of the engine decreases, the spring H pressing against the pin a' moves the disk D in the direction opposite to its rotation, and thereby returns the cam d thereon to a position where the charge will be ignited at a later period.

As the entire frame B′ is journaled on its hub B in the support B^3, it may be conveniently swung around for properly locating the spark with reference to the stroke of the engine, for which the frame is secured in position by means of the rod I. This swinging movement of the frame may also be employed with advantage when it is desired to have a late spark while the engine is running fast, by which means the speed of the engine is sometimes governed or controlled.

When it is desired to employ the above-desired igniting device upon a multiple-cylinder engine, the casing B' is made of sufficient size to contain a number of contacts corresponding to the number of engine-cylinders. In Fig. 8, for example, there is illustrated an igniter for a four-cylinder engine, the contacts being equally spaced within the casing B' around the shaft A, so that each of the movable contacts will be operated upon at the proper time by the rotation of cam-disk D and the governor-weights *c c'*.

Having thus described my invention, what I claim is—

1. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a rotatory driven member adapted to engage one of said contacts to bring the contacts together, a driving member for said rotatory driven member, the latter being capable of a limited rotatory movement independent of its driver, means connected with the movable contact to accelerate the movement of the rotatory driven member after the latter has brought said contacts together, whereby the contacts will be quickly separated, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

2. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a rotatory disk having a cam adapted to engage one of said contacts to bring the contacts together, a driving-shaft for said disk, connections between the disk and shaft to permit a limited independent rotatory movement of the disk, a spring connected with the movable contact to accelerate the movement of the disk after the latter has brought said contacts together, whereby the contacts will be quickly separated, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

3. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a rotatory member adapted to engage one of said contacts to bring the contacts together, a driving member for said rotatory member, connections between the driving and rotatory members to permit a limited independent rotatory movement of said rotatory member, a centrifugal governor operated by the driving member to move the rotatory member in relation to the driving member, whereby the contact will be made at a time earlier or later in the movement of the driving member, means connected with the movable contact to accelerate the movement of the rotatory member after the latter has brought said contacts together, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

4. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a driving member, a rotatory member having a pin-and-slot connection with the driving member to permit a limited independent motion of the rotatory member, means on the rotatory member to bring said contacts together, means connected with the movable contact to accelerate the movement of the rotatory member after the latter has brought the contacts together, whereby the contacts will be quickly separated, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

5. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a rotatory disk having a cam adapted to engage one of said contacts to bring the contacts together, a driving member for said disk, pin-and-slot connections between the disk and driving member to permit a limited independent rotatory movement of the disk, a spring connected with the movable contact to accelerate the movement of the disk after the latter has brought said contacts together, whereby the contacts will be quickly separated, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

6. An igniting device for hydrocarbon-engines, comprising normally separated contacts, a rotatory member adapted to engage one of said contacts to bring the contacts together, a driving member for said rotatory member, pin-and-slot connections between the driving and rotatory members to permit a limited independent rotatory movement of said rotatory member, a centrifugal governor operated by the driving member to move the rotatory member in relation to the driving member, whereby the contact will be made at a time earlier or later in the movement of the driving member, means connected with the movement of the rotatory member after the latter has brought said contacts together, and means for regulating the period of engagement of the contacts to maintain such period substantially constant for various speeds of the engine.

7. An igniting device for hydrocarbon-engines, comprising a fixed contact and a movable spring-contact, a driving-shaft rotated at a speed having a fixed relation to the speed of the engine, a disk free to rotate to a limited extent faster or slower than said shaft, a cam or projection on said disk adapted to engage the spring-contact to close the contacts, and a weight-arm interposed between the shaft and the disk and operating by centrifugal force to move the disk with respect to the shaft, said weight-arm having a projection

cooperating with the cam on the disk all so constructed and arranged that the weight-arm controls the length of time of contact with respect to the rotation of the shaft and the spring-contact accelerates the movement of the disk to secure a quick break at the contacts.

8. An igniting device for gas or gasolene engines, comprising normally separated contacts, a driving-shaft rotated at a speed that has a fixed relation to the speed of the engine, a disk free to rotate to a limited extent faster or slower than said shaft, a short projection or cam on said disk adapted to engage the movable contact and close the contacts for a short period, two weight-arms interposed between the shaft and disk, said weight-arms affected by centrifugal force and adapted to move said disk in relation to said shaft, a projection or cam on one of said weight-arms adapted to move out and add to the length of the cam on said disk, whereby the length of time of the electrical contact will be made longer or shorter.

9. An igniting device for gas or gasolene engines, comprising normally separated contacts, a driving-shaft rotated at a speed that has a fixed relation to the speed of the engine, a disk connected to said driving-shaft, a projection or cam on said disk adapted to engage the movable contact and close the contacts, one or more weighted arms secured to said disk, and a projection or cam on one of said arms adapted to be moved by centrifugal force and add its length to the cam on said disk, whereby an electrical contact for a longer or shorter period will be made.

In testimony whereof I affix my signature in presence of two witnesses.

FAY O. FARWELL.

Witnesses:
GEORGE WEARMOUTH,
FLOYD A. OATEY.

No. 857,715 PATENTED JUNE 25, 1907

A. E. BRILLIÉ.

MEANS FOR AUTOMATICALLY TIMING THE SPARK FOR PRODUCING IGNITION IN EXPLOSION MOTORS.

APPLICATION FILED DEC. 24, 1906

2 SHEETS—SHEET 1.

Fig. 1.

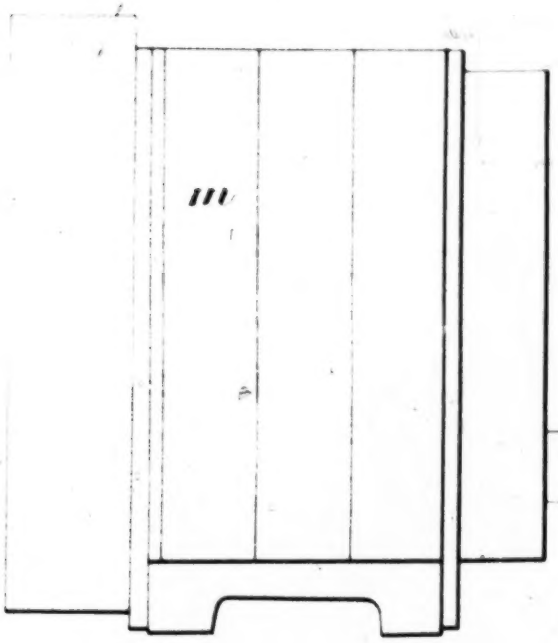

Fig. 2

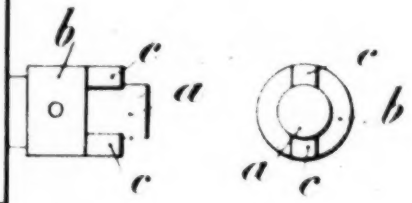

Fig. 3.

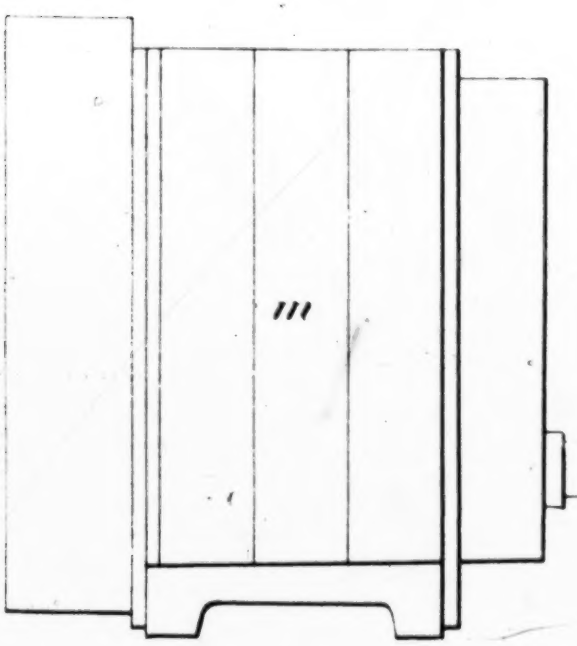

Fig. 6.

Witnesses:
Laura Franck
Kathryn Donovan

Inventor:
Auguste Eugène Brillié
by Albert Mack
his Attorney

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No. 857,715. PATENTED JUNE 25, 1907.

A. E. BRILLIÉ.

MEANS FOR AUTOMATICALLY TIMING THE SPARK FOR PRODUCING IGNITION IN EXPLOSION MOTORS.

APPLICATION FILED DEC. 24, 1906.

2 SHEETS-SHEET 2.

Fig. 3.

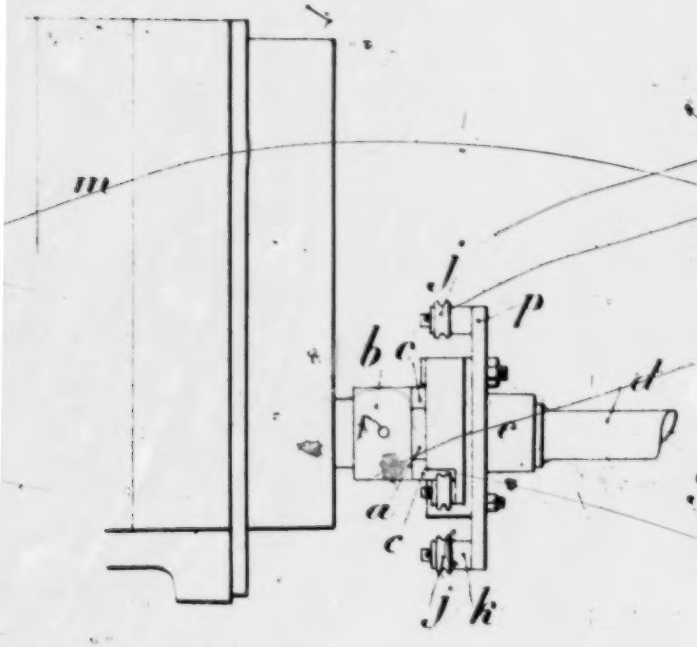


Fig. 4.

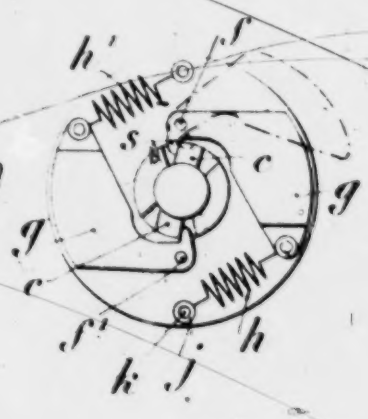
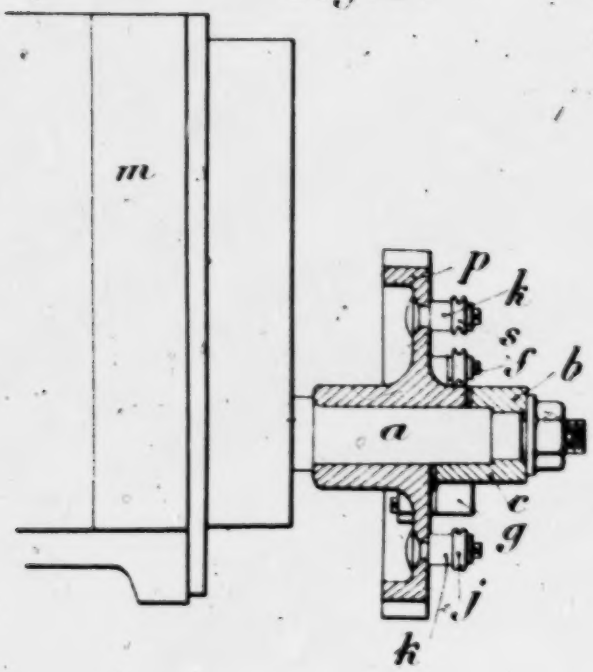


Fig. 7.



Witnesses:
Lorna Franck
Zachrya Sonoran

Inventor:
Auguste Eugène Brillié
by A. D. Minnis

UNITED STATES PATENT OFFICE.

AUGUSTE EUGÈNE BRILLIÉ, OF PARIS, FRANCE, ASSIGNOR TO SOCIÉTÉ ANONYME DES AUTOMOBILES EUGÈNE BRILLIÉ, OF PARIS, FRANCE.

MEANS FOR AUTOMATICALLY TIMING THE SPARK FOR PRODUCING IGNITION IN EXPLOSION-MOTORS.

No. 857,715. Specification of Letters Patent. Patented June 25, 1907.

Application filed December 24, 1906. Serial No. 349,227.

To all whom it may concern:

Be it known that I, AUGUSTE EUGÈNE BRILLIÉ, a citizen of France, residing at 60, Boulevard Periere, Paris, France, have invented new and useful improvements in Means for Automatically Timing the Spark for Producing Ignition in Explosion-Motors, of which the following is a specification.

The present invention relates to means for automatically timing the spark for producing ignition in explosion motors.

When the motor is working at low speed or in starting the same the ignition should occur near the dead point of the piston stroke, and as the speed of the motor increases the explosions or ignitions should be correspondingly advanced. The object of the present invention is to produce means for automatically accommodating the time of the spark production and consequent ignition or explosion to the speed of the motor.

In the accompanying drawing wherein two forms of the invention are illustrated, Figure 1 is a side elevational view of a magneto igniter; Fig. 2 is an end elevational view of the magneto armature shaft and its coupling member; Fig. 3 is a side elevational view of the magneto igniter coupled to the motor shaft (the motor being omitted); Fig. 4 is an elevational view of a disk and certain accessorial features employed in my invention; Fig. 5 is a side elevational view of a modified form of magneto igniter; Fig. 6 is an end elevational view of the magneto shaft and coupling member thereon; and Fig. 7 is a side elevational view partly in section, of a modified form of the invention.

In the drawing *m* indicates a magneto igniter of any approved form provided with the usual armature shaft or spindle *a*. In the form of the invention illustrated in Figs. 1 to 4 and wherein the magneto igniter is assumed as being driven by means of a spindle the shaft *a* carries a sleeve *b* having projections *c c*, thus providing the male member of a coupling, the female member of which is carried by the motor shaft as hereinafter described.

The motor shaft is designated in the drawing by the character *d* (no motor being shown as the same forms no part of the present invention) and is provided at or near its free end with a rigidly secured socket *e*, having internal grooves or cut out portions, preferably sector shaped, to receive the projections *c c* of the sleeve *b* and to permit such projections to be rotated therein within limits defined by the walls of the grooves or cut out portions. It will be understood that the socket *e* forms the female member of the coupling between the motor shaft and magneto igniter shaft.

Secured to or near the forward end of the motor shaft *d*, is a disk *p*, preferably of circular form, and carrying upon the face directed toward the magneto igniter a pair of pawls or fingers, *s*, *s*, pivoted upon the pins *f*, *f'* and having weighted extensions *g*, *g*, preferably formed integrally therewith. To the lower end of each extension *g* is secured one end of a retractile spring *h* or *h'* the other end of which engages a pulley *j*, secured to a stud *k* projecting outwardly from the face of the disk *p*.

It will be understood that when the motor and magneto igniter shafts are coupled, the projections *c c* reach into the grooves formed in the socket *e* and the fingers *s s* are in engagement with the projections *c c* as shown in Fig. 4. In starting the motor or when the latter is running at low speed the relative position of the parts will be that shown in full lines in Fig. 4, but when the motor and its shaft *d* are running at high speed, the weighted extensions *g* will overcome the tension of the springs *h* or *h'* and fly apart under the influence of centrifugal force, as shown in dotted lines in the same figures, causing the fingers *s s* to ride up on the projections *c c* and thus causing the armature shaft *a* to advance relatively to the shaft *d* and as a consequence advancing the time of the spark production by the armature and its appurtenant parts, (the armature and its appurtenant parts referred to not being shown on the drawing). The extent of the advance of the magneto igniter shaft is dependent upon the extent to which the fingers *s s* ride up on the projections *c c*, the latter function being governed by the rate of rotation of the shaft *d*.

In the form of invention illustrated in Figs. 5 to 7, the magneto igniter *m*, carries upon its armature spindle or shaft *a* the disk *p* having gear teeth cut in its periphery through the medium of which the shaft *a* may be driven. *b* represents the sleeve having the projections *c c* and is carried by the motor

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shaft. The disk *p* carries the fingers *s* and other parts above described as held thereby and is grooved to receive the projections *c c* of the sleeve *b*. The form of invention illustrated in Figs. 5 to 7 is a virtual reversal of that shown in Figs. 1 to 4 and operates in substantially the same manner.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a device of the character described, the combination with a magneto igniter provided with an armature shaft, of a sleeve thereon carrying projections, a motor shaft provided with a socket having grooves or cut out portions into which said projections are adapted to enter, and means acting upon said projections for advancing the armature shaft relatively to the motor shaft.

2. In a device of the character described, the combination with a magneto igniter provided with an armature shaft, of a sleeve on said shaft having projections formed thereon, a motor shaft carrying a socket having sector shaped grooves wherein the said projections are adapted to enter and have limited rotary motion, and means engaging said projections to thereby advance the armature shaft relatively to the motor shaft upon rotation of the latter.

3. In a device of the character described, the combination with a magneto igniter provided with an armature shaft, of a sleeve carried by said shaft and having lateral projections, a motor shaft, a socket upon said motor shaft having grooves wherein the projections enter and have limited rotary motion, a disk carried by said motor shaft, and means carried by said disk for engaging said projections and advancing the armature shaft in a degree corresponding to the rate of rotation of said motor shaft.

4. In a device of the character described, the combination with a magneto igniter provided with an armature shaft, of a sleeve on said shaft having lateral projections, a motor shaft provided with a socket having grooves into which said projections are adapted to enter, a disk rigidly secured to said motor shaft, and weighted fingers pivoted to said disk, said fingers being adapted to engage said projections and advance the armature shaft relatively to the motor shaft in a degree corresponding to the rate of rotation of the latter.

5. In a device of the character described, the combination with a magneto igniter, provided with an armature shaft, of a sleeve on said shaft having lateral projections, a motor shaft provided with a socket having grooves into which said projections are adapted to enter, a disk rigidly secured to said motor shaft, fingers pivoted upon said disk and weighted extensions formed integrally with said fingers.

6. In a device of the character described, the combination with a magneto igniter provided with an armature shaft, of a sleeve on said shaft having lateral projections, a motor shaft provided with a socket having grooves into which said projections are adapted to enter, a disk rigidly fixed upon said motor shaft forward of said socket, a plurality of fingers pivoted upon said disk, weighted extensions formed integrally with said fingers, and retractile springs controlling said extensions.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

AUGUSTE EUGENE BRILLIÉ.

Witnesses:

LOUIS GARDET,

HANSON C. COXE.

No. 863,151. PATENTED AUG. 13, 1907.

B. P. CHURCHILL.

AUTOMATIC SPARK ADVANCER.

APPLICATION FILED JULY 20, 1906.

Fig. 1.

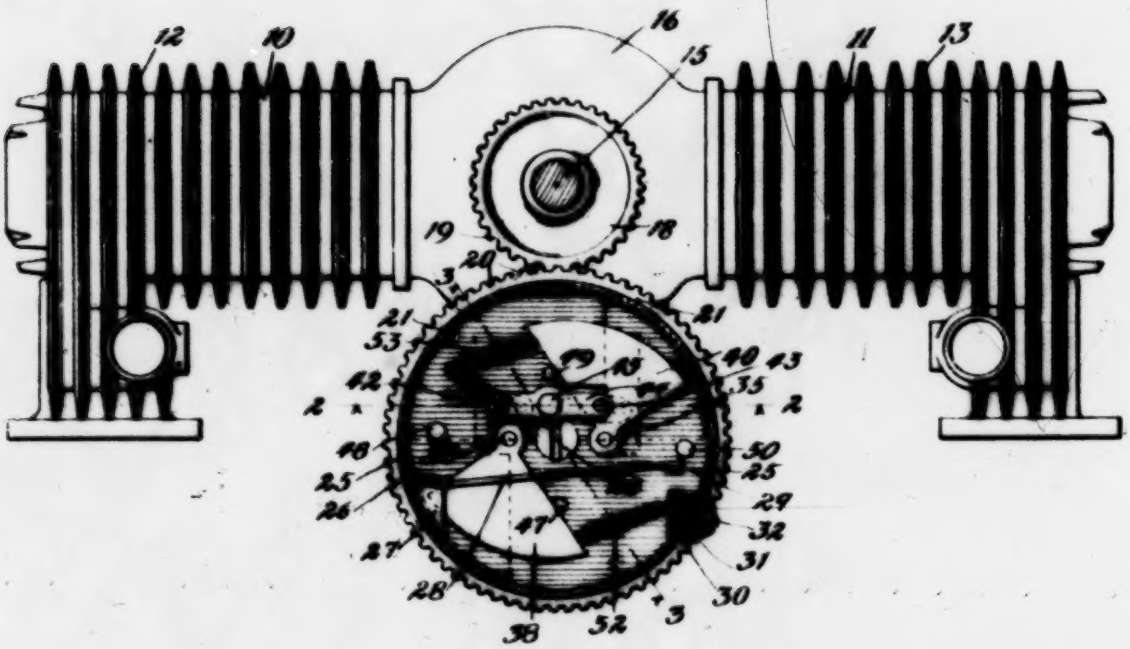

Fig. 2.

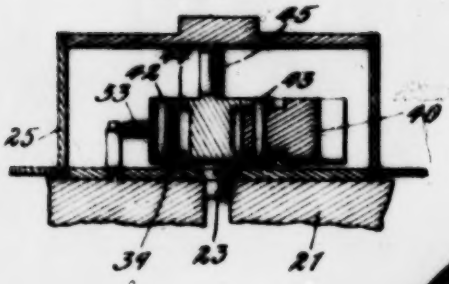

Fig. 3.

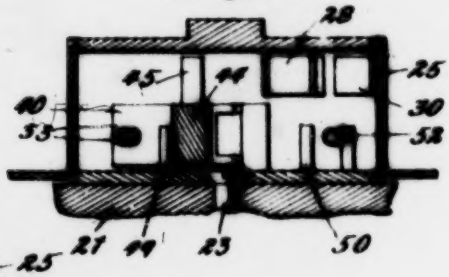

Fig. 4.

Witnesses:

Inventor:

Benn Pitman Churchill.

By Cheever Cox

Atty

UNITED STATES PATENT OFFICE.

BENN PITMAN CHURCHILL, OF MILWAUKEE, WISCONSIN, ASSIGNOR OF TWO-THIRDS TO RETTA PIERCE DAVENPORT AND EVERETT O. ROCKWELL, OF CHICAGO, ILLINOIS.

AUTOMATIC SPARK ADVANCER.

No. 863,151. Specification of Letters Patent. Patented Aug. 13, 1907.

Application filed July 28, 1906. Serial No. 328,186.

To all whom it may concern:

Be it known that I, BENN PITMAN CHURCHILL, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a certain new and useful Improvement in Automatic Spark-Advancers, of which the following is a specification.

My invention relates to mechanism for controlling sparking apparatus of gas engines ordinarily used upon automobiles.

As is well known, it is essential to the proper operation of a gas engine that the gas in the working cylinder be fully exploded at the instant the piston begins its working stroke, and as it always takes substantially the same amount of time to explode the gas within the cylinder, it is necessary, where the exploding or sparking is affected by the revolution of a wheel or other corresponding part within the engine mechanism, to cause such revolving mechanism to operate the sparking mechanism at a considerable earlier point in its revolution than is necessary when the engine is running slower. In other words, it is necessary to advance the point of spark.

The object of my invention is to provide automatic mechanism by means of which the point of spark is advanced a proper amount as the speed of the engine increases and is varied as the speed of the engine varies.

More in detail my invention consists in the application of a governor mechanism adapted to be moved by the varying speed of the engine to a pin which operates the sparking mechanism, the governing mechanism being so constructed and arranged that this pin is moved backward and forward in a circle about the center of the wheel or shaft which carries it, a sufficient amount so that it operates the sparking mechanism earlier or later as required.

My invention further consists in details of construction which will be hereafter more fully described and claimed.

Figure 1 is a side external view of the two cylinders of a gas engine, and a transverse sectional detail view of the primary and secondary shafts of said engine and the mechanism of my invention for sparking one of the above cylinders applied thereto, there being a duplicate device for the other cylinder located at some convenient point, usually on the opposite side of the two cylinders. Fig. 2 is a sectional detail view of my preferred mechanism taken on the line 2—2 of Fig. 1; Fig. 3 is a corresponding sectional detail view taken on the line 3—3 of Fig. 1; Fig. 4 is a detail view showing the position of the governing mechanism when the engine is running at full head, and when the parts have traveled from the position of Fig. 1 through approximately 180° to a point in which the engine is in the act of sparking.

While the cylinders of the gas engine form no part of the invention here in question, I have, in order to show the relation of the mechanism to the gas engine, illustrated two gas engine cylinders 10 and 11, having on their exterior surfaces cooling devices 12, 13 of the ordinary type. These two cylinders are arranged on opposite sides of the primary crank shaft 15 carrying within the casing 16 crank-arms and connecting-arms (not shown) connected with pistons (not shown) within the cylinders.

On the shaft 15 is a gear wheel 18, having on its circumference gear teeth 19 meshing with other gear teeth 20 upon a larger wheel 21 rigidly secured to the secondary shaft 23 of the engine. Mounted about, but independent of this shaft 23 is a stationary casing 25 forming a part of the frame of the engine. On one side of this frame 25 and connected thereto by a screw 26, or other suitable means, is a contact 27 to which is rigidly secured one end of a spring-switch 28. This switch 28 carries upon its opposite end a contact-point 29 adapted to temporarily engage the contact-block 30. This contact-block 30 is insulated from the casing 25 by the insulation 31, or other suitable means, and has connected to it a binding post 32. This binding post 32 is, in a gas engine, always connected to a battery or other source of electrical energy (not here shown), and is thence connected in the ordinary manner through an induction coil to one terminal of the spark-plug within the engine cylinder. The opposite side of the spark-plug is always connected to the frame of the engine, so that electricity can travel from said second side of the spark plug back to the block 27 and switch 28.

The parts thus described constitute ordinary construction, and, in this form no part of my invention.

In order to cause the switch 28 to move from the position of Fig. 1 to that of Fig. 4, and in order to cause the moment of sparking to be advanced, as and for the reasons heretofore stated, I add to the mechanism just described that of my invention, which I will now describe. Upon the wheel 21, heretofore described, and inside the casing 25, adjacent to the switch 28, but clear of said switch, I place two pins 34 and 35, equidistant from the center of the secondary shaft 23. Upon the pin 34 I journal a triangular governor weight 38 having extending from it on the opposite side of the pin 34, a short lever arm 39, with the result that this arm and the governor weight form together a lever of the first class pivoted at 34. Similarly, I journal upon the pin 35 and within the casing 25, another governor weight 40 exactly like the one 38 heretofore described, except that the extension arm is omitted. Upon the arm 39 is a pin 42, a certain distance from the center of the pin 34. Upon the body of the governor weight 40 is a pin 43, a distance from the pin 35 equal to the distance of the pin 42 from the pin 34. Both pins 42 and 43 are, as shown in the drawings, upon the same side

of a center line of the wheel 21, drawn through the pins 34 and 35, so that a connecting link 44 pivotally connected to the pins 42 and 43, is, as shown, to one side of the center of the secondary shaft and the wheel 21. On this connecting link 44 is a contact pin 45 of such a length and location that it will, at one point in the revolution of the wheel 21, strike the switch 28 and move it from the position of Fig. 1 to that of Fig. 4, after passing which point the spring switch 28 moves back to the position of Fig. 1.

Upon the wheel 21 I provide two stops 47 and 48 adapted to limit the motion of the governor weight 38, and in corresponding positions upon the wheel I provide two other stops 49 and 50 adapted to limit the motion of the governor weight 40. Connected to the governor weights 38 and 40 are suitable springs 52 and 53 adapted to hold said weights in the normal position shown in Fig. 1.

In the operation of the mechanism, assume that the parts are as shown in Fig. 1, in which position the engine starts from rest and moves slowly. The contact pin 45 will, during rotation at this speed, be carried around in a circle by the wheel 21, and will, every time it strikes the spring switch 28, move it to the position of Fig. 4, thereby exploding gas within the engine cylinder. As, now, the speed of the engine is accelerated, the governor weights 38 and 39 are, in the well-known manner, moved outward from the position of Fig. 2 toward that of Fig. 4, against the action of springs 52 and 53. This motion of the governor weights tends to move the pin 45 clockwise in the arc of a circle about the center of the wheel 21. Or, in other words, to angularly advance it with reference to a fixed point upon the circumference of the wheel 21, so that as the wheel revolves, it contacts with the spring switch 28 sooner in the revolution of the wheel 21 than it does when the parts are in the position of Fig. 1. When this outward motion of the governor weights has reached its maximum, or the position of Fig. 4, this contact-pin 45 is advanced as much as possible, and as much as is necessary for the proper operation of the engine. When, now, the engine begins to slow down, the governor weights begin to move backward under the action of the springs 52 and 53, from the position of Fig. 4 to that of Fig. 1, with the result that the contact-pin 45 is withdrawn or retracted from this advanced position a proper amount to give the engine the proper sparking point for the speed at which the engine is then running.

Having thus described my invention, what I claim as new and desire to secure by Letters-Patent is

1. In a gas engine, the combination of a rotating member, a switch connected with the sparking mechanism of the engine, a governor weight movable with reference to the rotating member, a link connected to said governor, extending along one side of the center of the rotating member, a contact mounted on the link adapted to engage the switch, means for so guiding said link that as the governor weight moves it moves said contact on the link about the center of the rotating member for the purposes set forth.

2. In a gas engine, the combination of a rotating member, a switch connected with the sparking mechanism of the engine, a governor weight pivoted to the rotating member at one side of its center, a link connected to said governor, extending along one side of the center of the rotating member, a contact mounted on the link adapted to engage the switch, means for so guiding said link that as the governor weight moves it moves said contact on the link in approximately the arc of a circle about the center of the rotating member for the purposes set forth.

3. In a gas engine, the combination of, a rotating member, a stationary switch connected with the sparking mechanism of the engine, two governor weights pivoted to the rotating member on opposite sides of its center, an arm extending from one of said weights, a link connecting said extending arm on one weight and the body of the other weight, spring mechanism holding said weights in normal position, and a contact member mounted on said link adapted to engage said switch, the whole arranged to operate as described, for the purposes set forth.

In witness whereof, I have hereunto subscribed my name in the presence of two witnesses.

BENN PITMAN CHURCHILL.

Witnesses:
HOWARD M. COX,
E. C. ROCKWELL.

P-65

A. L. RIKER.

SPARK ADJUSTING STARTING MEANS FOR AUTOMOBILES.

APPLICATION FILED NOV. 4, 1902

906,290. **Patented Dec. 8, 1908**

3 SHEETS—SHEET 1

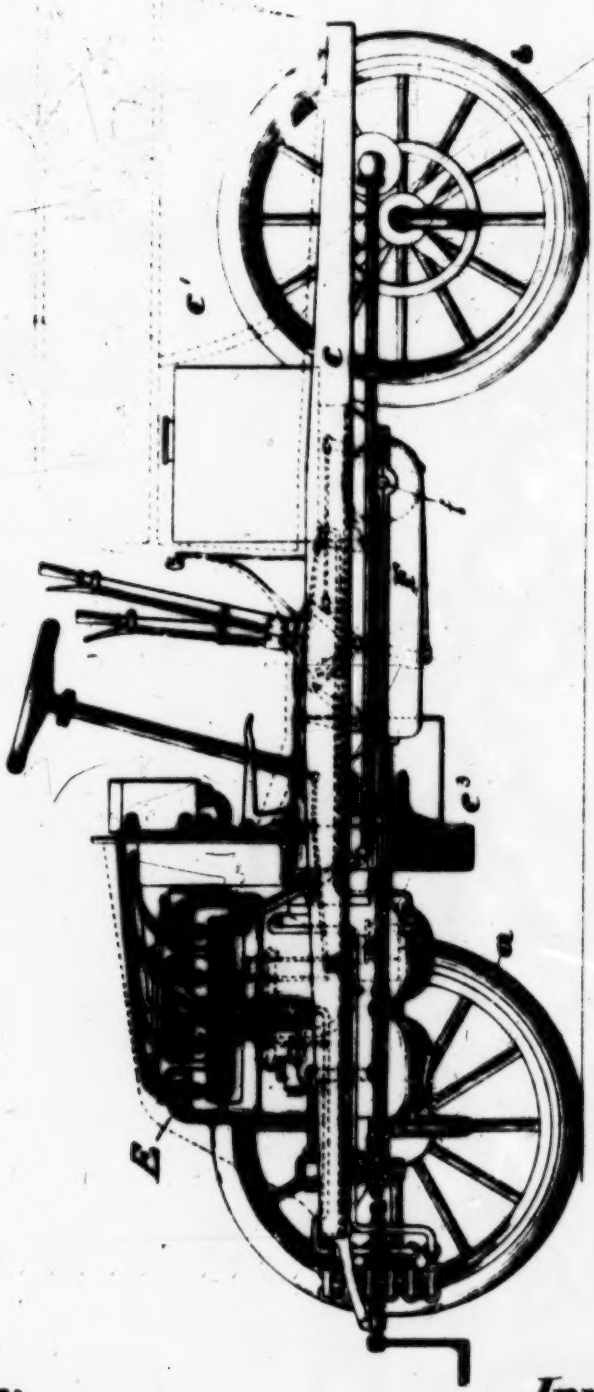

Fig. 1.

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SPARK ADJUSTING STARTING MEANS FOR AUTOMOBILES.

APPLICATION FILED NOV. 4, 1903.

906,290. Patented Dec. 8, 1908

3 SHEETS—SHEET 2

Fig. 2.

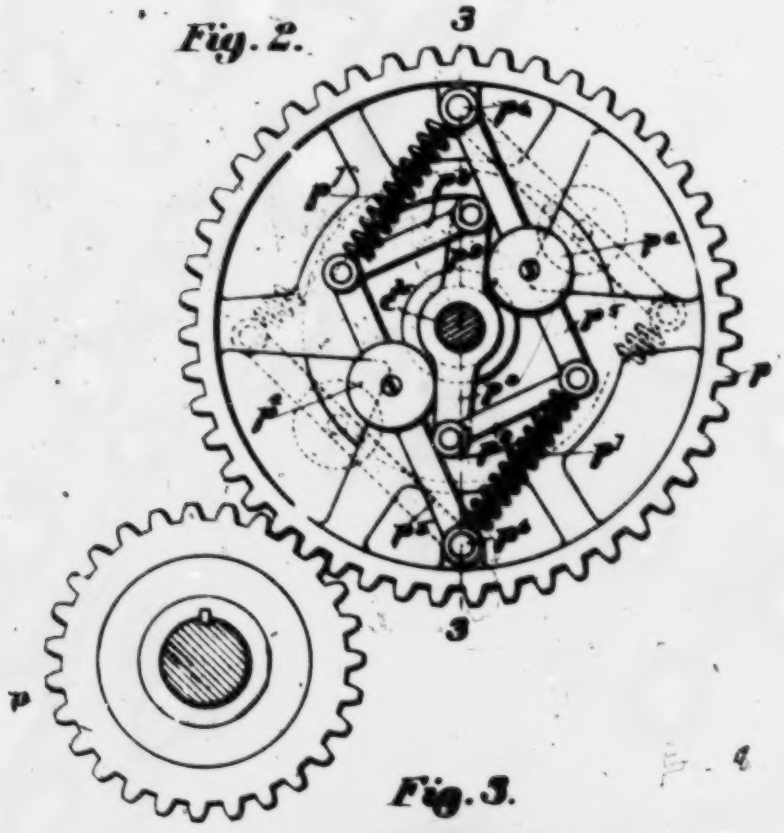
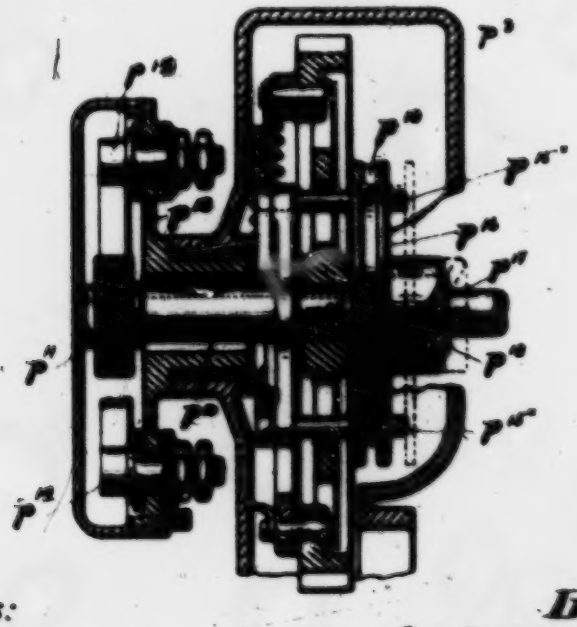


Fig. 3.



Witnesses:
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Andrew L. Riker,
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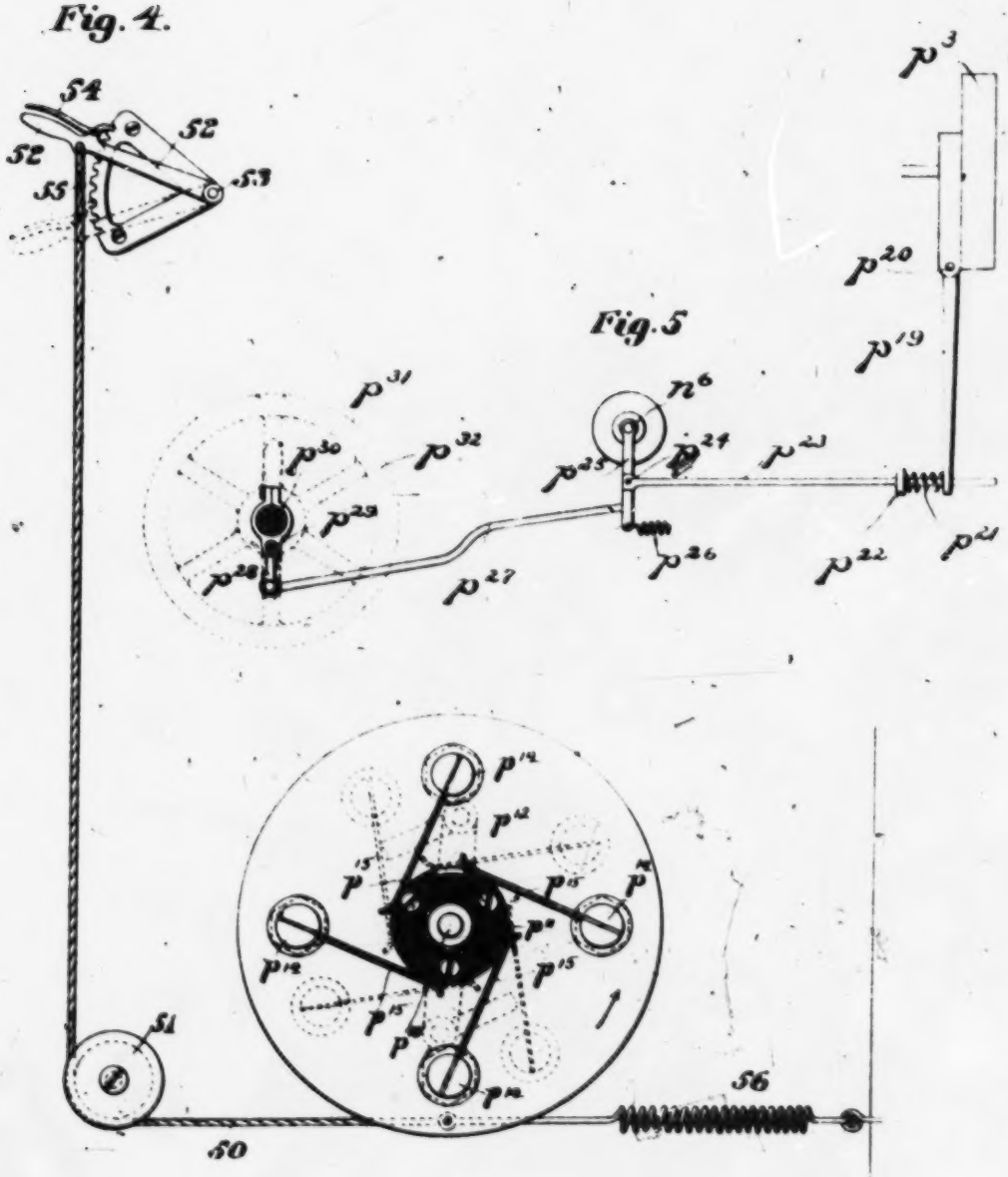
SPARK ADJUSTING STARTING MEANS FOR AUTOMOBILES.

APPLICATION FILED NOV. 4, 1907.

906,290. Patented Dec. 8, 1908

3 SHEETS—SHEET 3

Fig. 4.



Witnesses:
Walter G. Lombard
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Inventor:
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by Warren L. Emery
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UNITED STATES PATENT OFFICE.

ANDREW L. RIKER, OF SHORT HILLS, NEW JERSEY, ASSIGNOR TO THE "LOCOMOBILE" COMPANY OF AMERICA, OF NEW YORK, N. Y., A CORPORATION OF WEST VIRGINIA.

SPARK-ADJUSTING STARTING MEANS FOR AUTOMOBILES.

No. 906,290. Specification of Letters Patent. Patented Dec. 8, 1908.

Application filed November 4, 1903. Serial No. 180,032.

To all whom it may concern:

Be it known that I, ANDREW L. RIKER, a citizen of the United States, residing at Short Hills, in the county of Essex and State of New Jersey, have invented an Improvement in Spark-Adjusting Starting Means for Automobiles, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to motor vehicles of the type employing internal combustion engines, wherein the ignition is produced by an electric spark.

In starting an internal combustion engine, the sparking and ignition should occur immediately at the beginning of the working stroke of the piston, but as the engine gathers speed, the sparking must be advanced, it occurring, at high speed, frequently at or about the middle of the return stroke next preceding the working stroke, this early ignition being necessary not only to furnish a cushion for the reciprocating parts of the engine, but also to provide the expansive power resulting from the ignition in sufficient time to perform its work in driving the rapidly moving piston.

The prevailing practice at present is to provide motor vehicles with suitable speed responsive, governing means, which shall advance the sparking in proportion to the increase of speed. But I have found it difficult to provide a speed responsive device or governor which shall be reliable and properly responsive at high speeds and which will also produce the required adjustments of contacts at very low speeds, particularly when the engine is stopped and the contacts are to be left in position for again starting the engine.

My present invention comprehends a speed responsive or governing means which shall furnish the required adjustment of contacts for high speeds in combination with independent adjusting means preferably manually operable for preliminarily adjusting the contacts for sparking in such a manner as to enable the engine to be started.

My invention will best be understood from a description of one embodiment thereof in a typical motor vehicle.

Referring to the drawings,—Figure 1, in side elevation, illustrates a typical motor vehicle equipped with devices illustrating one embodiment of my invention; Fig. 2 is an enlarged detail of one form of speed responsive or governing means; Fig. 3 is a longitudinal section on the dotted line, 3—3, Fig. 2; Fig. 4 is a detail illustrating the fixed and movable contacts and independent means for adjusting the same for starting the engine; and, Fig. 5, a diagram illustrating the connections between the governor and throttling devices.

Referring to the drawings, particularly to Fig. 1, the motor vehicle may be of any suitable or desired type, the same as illustrated comprising the steering and propelling wheels, *a*, *b*, the spring supported frame, *c*, body, *d*, internal combustion engine, E, clutch, *e*, transmission gear, F, jackshaft, *f*, suitably connected with and to rotate the propelling or driving wheels, *b*, all of which are and may be of usual or desired construction so far as concerns my present invention.

Referring now particularly to Figs. 2, 3, and 4, the engine crankshaft as here shown, is provided with a pinion, *p*, which drives a wheel, *p'*, keyed to and rotating the shaft, *e*, which may be the cam shaft for actuating the valve mechanism of the engine. This wheel, *p'*, carries a pair of centrifugal weights, *p²*, mounted in usual manner, as, for instance, upon the arms, *p³*, fulcrumed at *p⁴*, upon the wheel and having their outer ends controlled by springs, *p⁵*, tending to draw said weights and arms normally towards the axis of rotation of the wheel.

The free, spring controlled ends of the weighted arms, *p³*, are connected by links, *p⁶*, with the radial arms, *p⁷*, of a sleeve, *p¹⁰*, loosely mounted upon the cam shaft, *e²³*. This sleeve at its outer end, at the left, Fig. 3, carries an insulating head, *p¹¹*, in which, see Fig. 4, is set a contact piece, *p¹²*, the face of which is flush with the peripheral face of the said head. Thus, the sleeve, *p¹⁰*, carrying this contact member, *p¹²*, not only rotates by and with the cam shaft wheel, *p'*, but it

has a further movement relative to the said wheel produced by the varying positions of the centrifugal governor weights, p^4, due to the speed of rotation of said wheel, which causes the said contact member, p^{12}, to occupy a more or less advanced position or lead relative to its wheel, according to the rotative speed of the latter.

Back of the insulating head, p^{11}, and preferably rotatably carried by the inclosing case, p^3, referred to, is a plate, p^{13} upon which are mounted and insulated therefrom four contact posts, p^{14}, (one for each cylinder of the engine, a four cylinder engine being herein assumed) shown as spaced uniformly 90 degrees one from the other and carrying respectively the four contact brushes, p^{15}, resting at their ends upon the periphery of the insulating head, p^{11}, referred to, and adapted on rotation of the said head to successively make contact with the rotating contact member, p^{12}, on the said head. Thus, at each complete rotation of the cam shaft wheel, and the head, p^{11}, there occur four successive closures of the electric circuits, said closures being for the four cylinders of the engine, to ignite the contents thereof at the proper times for operating the engine in the manner hereinbefore described.

As the speed of the engine increases, it is necessary to advance the sparking for the several cylinders, since increased speed of rotation requires earlier ignition. This is accomplished with the construction shown, for as the speed increases, the governor weights assume positions further from their axes of rotation, thus turning the sleeve, p^{10}, to advance the position of the contact member, p^{12}, to cause it to make earlier contact with the several brushes within which it rotates.

I control the supply of mixture for the engine also from this governor: Referring to Fig. 3, the pivot pins in the outer ends of the radial arms, p^9, and to which the links, p^8, are jointed, which pins are here designated p^{15x}, are shown as extended through the wheel, p', the arms of which are suitably shaped, to provide sufficient openings therefor, said pins at their remote ends passing through and closely fitting suitable openings in a circumferentially grooved disk, p^{16}, loosely mounted upon the hub of the cam shaft driving wheel, p', so that rocking movement of the radial arms, p^9, due to the action of the governor weights, will cause a corresponding rocking or rotative movement of the said disk, p^{16}, also on and relative to the said shaft, e^{2b}.

The hub of the disk, p^{16}, is grooved spirally at p^{17}, to receive a pin, p^{18}, projecting radially from the hub of the wheel, p', so that as the said grooved disk is rocked or rotated back and forth under the action of the governor weights, the spiral groove in the hub thereof acting upon the radial pin, p^{18}, will cause the said grooved disk to move axially in one or the other direction, according to the direction of its rotation, and consequently, corresponding to the movements of the governor weights. The groove in the periphery of this disk, see Fig. 5, receives the end of a lever, p^{19}, fulcrumed at p^{20}, in the casting, p^3, and bearing at its free end upon a spring, p^{21}, seated against a collar, p^{22}, fast on a rod, p^{23}. This rod is jointed at p^{24}, to an arm, p^{25}, which is fast upon the upper end of a spindle or stem, n^6, of any suitable throttle, which controls the supply of combustible mixture to the engine; consequently, as the said grooved wheel is shifted axially by the shifting governor weights, it will through the lever, spring and rod referred to, impart a corresponding rocking movement to the throttle, to increase or reduce the supply of mixture to the engine cylinders, and the spring, p^{26}, engaging the said arm, p^{25}, returns the latter upon return movement of the governor weights. Thus, the governor weights not only adjust the times of ignition, as required to maintain the speed at the proper point, but regulate also the supply of mixture to the engine cylinders for the same purpose. The centrifugal governor may therefore be relied upon to maintain a substantially constant speed, which speed may be varied as desired by proper adjustment of the weights and their connections. In operating the vehicle, however, it becomes necessary frequently to reduce the speed of the vehicle below that normally maintained by the automatic governor, and it is equally desirable, when occasion requires, to be able to increase the speed beyond that normally maintained by the governor. To provide for this I have connected with the cylindrical throttle arm, p^{25}, a rod, p^{27}, shown as leading to and connected with an arm, p^{28}, at the bottom of a rod, p^{29}, mounted in bearings preferably upon and at the side of the steering post, p^{30}, said rod, p^{29}, being fitted at its upper end with a handle, p^{31}, conveniently arranged with reference to the steering handle, p^{32}. Thus the operator, with one or the other of his hands, while steering the vehicle, may move the said handle, p^{31}, in one direction, as to the left, Fig. 5, and thus rotate the cylindrical throttle farther than it is rotated by the automatic governor and reduce the supply of mixture for the engine beyond that determined by the automatic governor and reduce the speed below the normal governor speed to any desired extent. On the other hand, by swinging said handle in an opposite direction, the throttle may be turned, to increase the supply of mixture to the engine to increase its speed, notwithstanding the automatic governor is tending to hold it down, the spring, p^{21}, between the rod p^{23},

and the arm, p^{19}, permitting the said rod to be moved in opposition to the said arm without disturbing the position of the latter as fixed by the governor. In any event, whether the speed be thus increased or reduced relative to the normal governor speed of the engine, the governor responds to the change in speed, and immediately adjusts the lead of the contact member, p^{12}, to meet the new speed. As heretofore stated, however, a governor or speed responsive device which is sensitive and accurate when running at high speeds, is not usually sensitive or accurate at very low speeds approaching a state of rest; and I have found that while the governor shown is capable of responding quickly to changes in running speed and keeping the lead of the sparking contact p^{12} always at a proper point for the particular speed for the time being, yet when the machine is stopped and the parts assume a state of rest, said governor does not with certainty restore the said contact, p^{12}, to the required position to cause ignition at the very beginning of the working strokes of the several cylinders. As a rule, a governor of this type when stopped will leave the said contact p^{12} in position where, if the engine be started, it would cause premature ignition, *i. e.*, ignition near the close of the return stroke next preceding a working stroke; which, of course, would prove detrimental. To overcome this objection, referring to Fig. 4, I have attached to or upon the brush carrying plate, p^{13}, a flexible connection or wire, 50, which is carried to and about a suitable pulley or sheave, 51, thence upward to and connected with a handle lever, 52, fulcrumed at 53, upon a suitable support, preferably on the dash board. The said lever may be provided as herein shown with a suitable latch device, 54, coöperating with a toothed sector, 55, by which said lever is held in desired position.

A spring, 56, attached to a suitable support is connected with the plate, p^{13}, said spring tending to rotate the said plate normally in a direction indicated by the arrow, Fig. 4, to advance the brushes, p^{15}, and thereby the time of sparking; such rotation of the said plate and brushes being resisted by the wire and lever, 52.

Assuming the engine to have stopped with its movable contact, p^{12}, in the position shown in Fig. 4, and with the brushes in the full line positions in the said figure, such position of said contact, p^{12}, relative to the cranks and pistons of the engines being such as would furnish the proper sparking for the engine when running at normal or slightly reduced speed, obviously would be too early for the initial starting of the engine. It is impossible to give to the said contact, p^{12}, a retrograde movement because of its connections with the governor weights, which are in a state of rest; consequently the lever, 52, is dropped into its dotted position, Fig. 4, thereby permitting the spring, 56, to rotate the plate, p^{13}, in the direction of the arrow to advance the brushes relative to the rotatable contact, p^{12}, which is equivalent to giving a retrograde movement to the said contact to delay the ignition for the several cylinders. The parts are so adjusted that when the said handle lever, 52, is dropped into its lowermost position, the adjustment of the brushes will be correct for starting the engine, that is, for producing the ignition at the commencement of the working stroke of each piston. The engine having been started, after it has acquired such speed that the governor commences to respond, the handle lever, 52, is again raised into elevated position, thus restoring the brush carrying plate, p^{13}, to its normal position against the tension of the spring, 56, and leaving the control of the sparking of the engine thereafter wholly in the governor, which exercises its control by varying the lead of the rotating contact, p^{12}. By this arrangement, I am enabled to construct the governor and its connections with the movable contact in a manner that will produce the best results and most accurate and sensitive adjustment of the contacts for running speeds of the engine, thus enabling me to derive the greatest benefit from the throttling of the mixture herein described. At the same time, the hand adjustment of the ignition contacts provides for the starting of the engine, without danger of its reversing to the injury of the one attempting to start it.

My invention obviously is not limited to the particular embodiment thereof here shown and described, as the same may be varied within the spirit and scope of the invention.

Claim.

1. In a motor vehicle provided with an internal combustion engine having sparking means, the combination with said engine and ignition contacts therefor, of speed responsive means to govern the relative operation of said contacts, and simultaneously operable means independent of the speed responsive means to govern the relative operation of said contacts for starting, while maintaining a like cycle of engine operation.

2. In a motor vehicle the combination of an internal combustion engine provided with sparking means, means for throttling the combustible mixture therefor, ignition contact devices, a speed governor and connections for adjusting the ignition to follow the throttled speed of the engine, and simultaneously operable means separate from said governor and its connections, to adjust the ignition for starting the engine.

3. In a motor vehicle provided with an in-

ternal combustion engine, the combination with throttling means therefor of a throttle controller responsive to the speed variations of the engine, means to throttle the engine independently of the speed thereof, sparking means having a timing adjustment responsive also to the same speed variations of the engine, and means under the control of the operator also to vary the timing of said sparking means for starting the engines irrespective of the engine speed.

4. In a motor vehicle provided with an internal combustion engine employing sparking means, the combination with said engine of independently and simultaneously operable governor and manually controlled sparking means therefor to effect independent adjustments of the time of ignition relatively to the working stroke while maintaining the same cycle of engine operation.

5. In a motor vehicle provided with an internal combustion engine employing sparking means, the combination with said engine, of circuit closing and breaking means including a rotary contact and one or more coöperating contact brushes, of governor means comprising a governor and its connections with said circuit closing and breaking means to change the relative angular position of said contact and said brushes, and means independent of said governor mean to vary the position of said contact brush or brushes for starting the engine.

6. In a motor vehicle provided with an internal combustion engine, a throttling device therefor, controlling means for said throttling device responsive to variations in the engine speed, means for controlling said throttling device irrespective of the speed responsive means, sparking means having a timing adjustment responsive also to the same speed variations of the engine, and means also to adjust the timing of said sparking means during engine operation independently of said speed controlled means and said throttle controlling means.

7. In a motor vehicle provided with an internal combustion engine, a throttling device therefor, means responsive to variations in the engine speed for controlling said throttling device, manual operating means for controlling said throttle, sparking means for said engine having a timing adjustment responsive also to the same speed variations of the engine, and manually operative means for adjusting the timing of said sparking means during engine operation independently of said manually operated throttle controlling means.

8. An internal combustion engine having throttling means therefor, a controlling device for said throttling means responsive to the speed variations of the engine, means also to control said throttling means irrespective of the speed responsive means, sparking devices having a timing adjustment to cause changes in the ignition to respond to speed changes in the engine, and additional controlling means also to adjust the timing of said sparking means during engine operation.

9. In a motor vehicle provided with an internal combustion engine, the combination with said engine of ignition means therefor, means responsive to the engine speed to vary the timing of ignition relatively to the working stroke, and separate controlling means also to vary the time of ignition relatively to the working stroke on the same cycle of operation independently of the engine speed.

10. In a motor vehicle provided with an internal combustion engine employing sparking means, the combination with said engine of ignition contacts therefor, means responsive to engine speed to adjust the sparking in advance of the working stroke for relatively high speeds, and separate controlling means to adjust said contacts independently of said speed responsive means to provide retarded ignition at or about the beginning of the working stroke for starting or on relatively slow speeds.

11. In a motor vehicle an internal combustion engine, ignition contacts for said engine, a speed governor controlling said contacts to adjust the timing of the engine ignition to correspond with the engine speed, an engine throttle also controlled by said governor, a controlling lever within the control of the vehicle operator, and connecting means between said lever and said ignition contacts permitting the manual adjustment of said contacts independently of the engine speed or the throttle control.

12. In a device of the class described, the combination with an internal combustion engine provided with fuel throttling means and ignition contacts, of speed governor means for controlling said contacts and said throttling means, and means independent thereof for separately governing the relative operation of said contacts for starting and independent of the action of said governor thereon.

13. In a device of the class described, an internal combustion engine provided with sparking means, fuel throttling means for said engine, means including a speed responsive governor for adjusting the ignition to follow the speed of said engine, simultaneously operable means to adjust the ignition for starting the engine independently of said governor adjustment, and means for limiting the action of said governor on said throttling means.

14. A motor vehicle provided with an internal combustion engine having a fuel throttling device and sparking means, the combination therewith of an independently and simultaneously operable governor and

manually controlled sparking means therefor, manually controlled contact devices for said sparking means to effect independent adjustments of said throttling device and time of ignition relative to the engine speed w' ile maintaining the same cycle of engine operation, and means for limiting the action of said governor on one of them.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

ANDREW L. RIKER.

Witnesses:
WM. S. TEEL, JR.,
JAMES ROCHE, JR.

G. W. WACKER.

MAGNETO.

APPLICATION FILED DEC. 23, 1915.

1,224,247. Patented May 1, 1917.

Fig. 1.

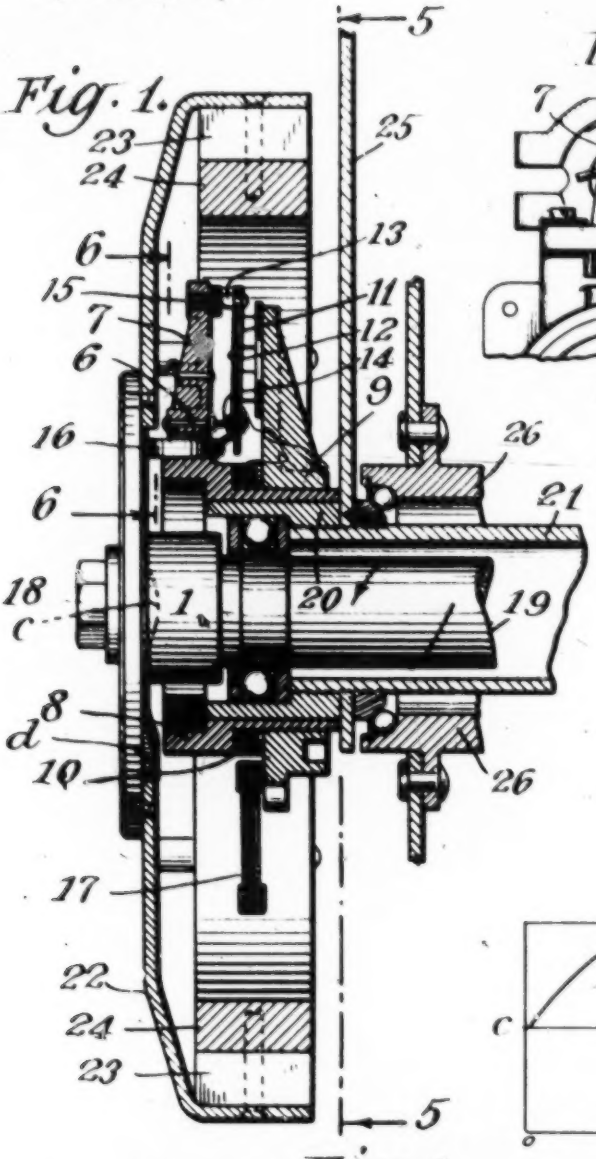


Fig. 6.

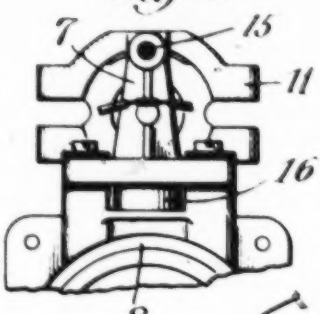


Fig. 2.

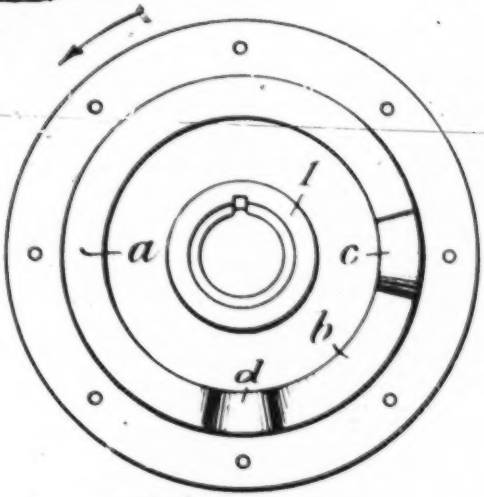


Fig. 3.

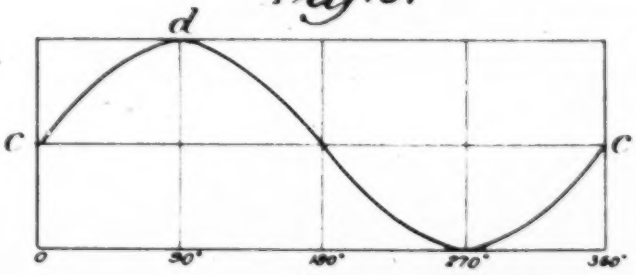


Fig. 4.

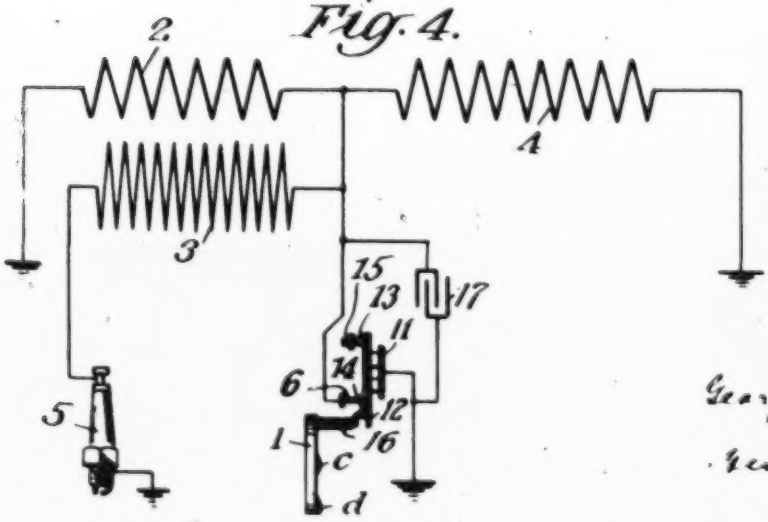
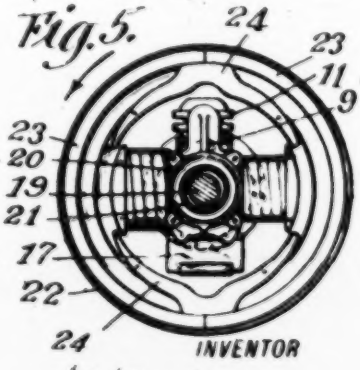


Fig. 5.



INVENTOR

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BY

Henry D. W. Williams

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UNITED STATES PATENT OFFICE.

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MAGNETO.

1,224,247. Specification of Letters Patent. Patented May 1, 1917.

Application filed December 23, 1915. Serial No. 68,446.

To all whom it may concern:

Be it known that I, GEORGE W. WACKER, a citizen of the United States, residing at Rutherford, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Magnetos, of which the following is a specification, reference being had therein to the accompanying drawings forming part thereof.

My invention relates to magnetos such as are employed for ignition purposes in connection with the internal combustion engines of self-propelled vehicles. My invention relates more particularly to the means for periodically making and breaking the short circuit of a short circuited primary coil. Other features of construction embodied in the same magneto which embodies my present invention and in part illustrated in the accompanying drawings form the subject of th.. other applications for patent filed by me on even date herewith, of which application Serial Number 68,443 relates more particularly to the armature construction, application Serial Number 68,444 to the construction of the interrupter or circuit breaker, and application Serial Number 68,445 to means for making electrical connection of the high tension coil to an outside conductor.

In regard to my present invention it is first to be noted that heretofore magnetos have been operated in two different ways as to the control of the circuits. According to one way, known as the open circuit system, the circuit of the short circuited primary coil is maintained normally open, being thus open during the greater part of a complete rotation and being closed only long enough to produce sufficient current flow to result in a spark from the spark coil when the closed circuit of the primary coil is broken, the circuit-controlling or circuit-making and circuit-breaking devices being constructed to operate in this way. According to the other way of operation, known as the closed circuit system, the short circuit of the primary coil is kept closed at all times excepting when broken substantially at periods or points of maximum current flow in order to produce an ignition current in the secondary coil or spark coil. In both systems of operation commonly the circuit is closed automatically by a spring and is opened or broken by means of a raised cam face or cam projection at the desired points of relative rotation of the relatively rotating parts of the magneto, for example, of its armature and its field magnet.

The normally open circuit system operates well electrically but there are mechanical difficulties and objections. For example, the extended raised cam surface, which is employed for both breaking the circuit and for maintaining it in the open condition, by reason of its pressure upon the spring-pressed cam roller or corresponding part results in excessive wear of such cam roller and the parts with which it coöperates. The construction of circuit-controlling means employed in the closed circuit system is substantially free from these mechanical defects but electrical difficulties are present. For example, particularly at high speed, what perhaps may not inaptly be termed the residue of current from a preceding electrical impulse seems to have a tendency to persist and to partially overlap upon the next succeeding current impulse in the opposite direction which it is desired to utilize for producing the next succeeding spark, with the result that an effective spark-producing current impulse will not be produced. However, whatever the explanation may be, this above electrical disturbance of the magneto circuits exists and must be reckoned with. In cases where the short circuit of the primary coil is broken at each succeeding period or time of substantially maximum current flow, for producing a spark at each such period of maximum current, the above mentioned objectionable electrical disturbance is not present. However, when a magneto is employed for producing a lesser number of sparks than that of which it is capable as determined by the successive peaks or rises of alternating current impulses, then the objectionable overlapping and interfering effects of any unused current pulsation or impulse of which the circuit has not been broken, is marked. For example, when a bipolar magneto, this being the common form, is employed for ignition purposes in connection with an internal combustion engine having only a single cylinder and the magneto is driven or rotated at engine speed, such, for example, as by reason of having its rotative parts mounted upon and rotative with the crank shaft of the engine, then in such an instance two opposite cur-

rent impulses or current peaks, will be produced at each rotation of the rotative parts of the magneto and of the engine shaft, and each of these current impulses is capable of producing a spark, but only one of these pulsating current impulses is required for effecting the desired ignition in the cylinder of the engine. In such a case, in operating with a circuit-controlling construction for producing an ignition spark under the normally closed circuit system, it has been found that the unused current impulse seriously interferes with the production of an effective ignition spark at the single time at which the circuit is broken.

It is an important object of my present invention to provide a construction operating on the normally closed circuit principle or system which will be substantially free from the above mentioned electrical difficulties and objections. I have discovered that if the short circuit of the primary coil or energizing coil be broken at a point of comparatively low and non-spark-producing current and in advance of the point at which the succeeding or following spark-producing current impulse has its circuit broken for producing a spark, that such next or following spark-producing current impulse will be stronger and will result in the production of an effective ignition spark. This improved result, so far as I am able to ascertain, apparently is due to the dissipation of left over or residual current and likewise of the residual magnetism, by reason of which the circuits are cleared and are enabled to start anew without interference to build up a strong spark-producing current impulse. I have found this advantageous result to be particularly marked in the case of a bipolar magneto such as above mentioned in which only one of the two alternating current impulses is employed for spark-producing purposes. Other more particular objects and advantages of my invention will hereinafter appear.

My invention includes circuit-controlling means adapted or so constructed as to clear the magneto circuit of objectionable electrical and magnetic effects or influences in advance of the production of a spark-producing electrical impulse in such circuit. My invention more particularly includes features of construction and combinations of parts as will appear from the following description.

I shall now describe the ignition magneto embodying the circuit-controlling means of my invention illustrated in the accompanying drawings and shall thereafter point out my invention in claims.

Figure 1 is a central vertical axial section of a complete magneto embodying my invention, some of the parts appearing in elevation.

Fig. 2 is a side or face elevation as viewed from the right in Fig. 1 of the field magnet hub having formed thereon a circuit-controlling cam.

Fig. 3 is a diagram illustrating the successive alternating current impulses and the points relatively thereto at which the circuit of the primary coil is successively broken.

Fig. 4 is a diagram of the circuits of the magneto.

Fig. 5 is a reduced vertical section on a plane indicated by the line 5—5 of Fig. 1 as viewed from the right and shows the complete magneto in side elevation.

Fig. 6 is a partial vertical section on a plane indicated by the line 6—6 of Fig. 1 as viewed from the left.

In carrying out my present invention a rotative field magnet support or hub 1 is provided upon its inner side with an annular circuit-controlling or circuit-making and circuit-breaking cam. This cam has an extended depressed cam face or surface *a* located in a single plane and which, in the construction shown, extends nearly three-quarters of the way around, which is to say, is nearly two hundred and seventy degrees in arcuate or circumferential length. The annular cam on the hub 1 is provided with another similar but shorter depressed cam surface *b* located in the same plane as the face *a* and which, in the construction shown, is almost ninety degrees or nearly one-fourth of the cam circumference in length. The depressed cam surfaces *a* and *b* are separated from each other at their adjacent ends by two similar rounded cam projections *c* and *d* which in the construction illustrated in the drawings are shown as spaced apart one-fourth of the circumference of the annular cam, being spaced ninety degrees apart from their middle or highest points, this spacing, of course, corresponding to a quarter rotation of the rotative magnet-carrying hub 1.

The magnet-carrying magneto hub 1 rotates in a counter-clockwise direction as seen in Figs. 2 and 5 and as viewed from the right in Fig. 1, so that the first cam projection *c* travels in a circular path ninety degrees or one-fourth of a rotation in advance of the second cam projection *d*. The first cam projection *c* is a circuit-clearing circuit-breaking cam projection and the second cam projection *d* is a spark-producing circuit-breaking cam projection. The timing is so arranged, as is particularly illustrated in Fig. 3 and as is there indicated by the letters *c* and *d*, that the first or circuit-clearing cam projection *c*, traveling ninety degrees in advance of the second or spark-producing cam projection *d*, will operate to break the circuit at a point midway between the peaks or points of maximum flow of the two oppo-

sitely flowing current impulses, or at a point where substantially no current is flowing. The second or spark-producing cam projection *d*, following ninety degrees behind the first or circuit-clearing cam projection *c*, will operate to break the circuit substantially at the maximum of the first current impulse after the breaking of the circuit by the advance cam projection *c*.

It is to be noted in this connection that each time the circuit is broken it will be immediately closed and that the spark-producing current impulse which is interrupted by the second cam projection *d* is produced during the time that the circuit is permitted to be closed by the shorter depressed cam surface *b*. After the spark-producing breaking of the circuit by the second cam projection *d* the circuit is permitted to remain closed throughout the travel of the extended depressed cam surface *a* during which time, as is illustrated in the diagram in Fig. 3, a second opposite current impulse is developed which rises to its maximum and then gradually subsides substantially up to the point where the circuit is again to be broken by the circuit-clearing advancing cam projection *c*.

The magneto illustrated in the drawings it is to be understood is bipolar, not only by reason of the diagrammatic indication in Fig. 3, but also as is shown in the other figures of the drawings illustrating the construction, particularly Fig. 5. In Figs. 1 and 5 the rotative position of the cam-carrying hub 1 relatively to the other parts of the magneto corresponds to that indicated by two hundred and seventy degrees in the diagram of Fig. 3, this being a maximum point of an unused alternating current impulse, the objectionable effects of which are dissipated by the advancing circuit-clearing cam projection *d*, such dissipation occurring at the indication O (or 360°) in Fig. 3 and, as will readily be understood, just prior to the building up or rise of current which is terminated by the second cam projection *d* which breaks the circuit at 90° for producing an ignition spark, as is also indicated in Fig. 3.

The other parts of the circuit-controlling mechanism which are coöperative with the annular cam having the cam surfaces *a*, *b*, *c*, and *d* formed on the rotative magnet-carrying hub 1, may be of any suitable construction, and these parts of the circuit-controller or circuit-breaker which are illustrated in the accompanying drawings, more particularly form the subject of my hereinbefore mentioned patent application Serial Number 68,444, and such parts are herein described together with other parts of the magneto only to a sufficient extent for the understanding of my present invention. Also the circuit arrangement or combination of coils diagrammatically illustrated in Fig. 4 of the drawings as included in the magneto which embodies my present invention is more particularly set forth and claimed in my hereinbefore mentioned patent application Serial Number 68,443. In this construction primary and secondary coils, respectively, 2 and 3 are provided which correspond respectively with the usual primary and secondary coils commonly employed in magneto construction, and there is also provided a separate additional reinforcing coil 4 for the primary coil 2, the reinforcing coil 4 being so arranged and connected as to act in harmony with and reinforce the inductive effect of the primary coil 2. In the wiring diagram illustrated in Fig. 4 the primary coil 2 and the secondary high tension or spark-producing coil 3 are shown as connected in multiple in a short circuit which is normally closed through the circuit controller or circuit breaker, and the supplemental reinforcing coil 4 is shown as connected in a short circuit through the circuit breaker in multiple relation with the primary coil 2 and the secondary coil 3, but when the circuit breaker or circuit controller is excluded, as when the circuit is broken, then the reinforcing coil 4 will be connected in series with the primary coil 2 and will also be in series with the secondary high tension coil 3, but the primary coil 2 and the secondary coil 3 will be in multiple relation with each other relatively to the reinforcing coil 4. The circuits are shown as of the grounded type, and one end of the winding of the high tension coil 3 is shown as connected to a usual spark plug 5.

The other parts of the circuit breaker which are coöperative with the circuit breaking cam of the hub 1 will now be described. In the construction illustrated one end of the winding of each of the three coils 2, 3 and 4 is electrically connected to a stationary contact terminal or contact point 6, shown as a stud, which is carried by a connector piece or contact post 7 which is mounted upon but insulated from the other parts of an armature frame, as most clearly appears in Fig. 6 of the drawings. The contact post 7 is mounted upon and insulated from a main frame part or armature hub 8 over a reduced portion of which fits a second frame part or collar plate 9 which clamps in place a laminated armature core 10.

The collar plate 9 has an upward projection or extension, as appears in Fig. 1, and a sheet metal circuit-closing or contact-making push spring 11 is mounted upon this frame extension. The sheet metal circuit-closing or contact-making spring 11 carries a contact-breaking lever bar 12 which is shown as secured at its upper end to the

spring 11 by means of a fulcrum pin 13 and as similarly secured near its lower end by means of a short stud 14 which forms a movable contact terminal or contact point coöperative with the stationary contact point or contact stud 6. The fulcrum pin 13 at the upper end of the lever bar 12 rests upon and is adapted to rock upon a fulcrum heel or bearing 15 of insulating material, such as hard rubber, shown as supported by the connector piece or contact post 7

Normally or when unrestrained the circuit-closing spring 11 will press the movable contact stud 14 into circuit-making engagement with the adjacent end of the stationary contact stud 6, as appears in Fig. 1 of the drawings, and the short circuit of the magneto coil will thereby be closed through the armature frame which forms a grounded connection, as indicated in Fig. 4. The lower projecting end of the circuit-breaking lever bar 12 is shown as off-set away from the circuit-closing spring 11 and this projecting offset end of the lever bar 12 is coöperative with a cam roller 16 of suitable insulating material, such as hard fiber.

The cam roller 16 is shown as loosely contained in a slot in the armature frame shown, as appears in Figs. 1 and 6, as formed between the base of the contact post 7 and the adjacent face of the armature hub 8. It is to be noted as appears in Fig. 1, that the cam roller 16 projects from its containing slot at both sides of the contact post 7 and of the adjacent part of the armature hub 8. At one side the cam roller 16 is engageable with the adjacent projecting end of the lever bar 12 and at the other side the cam roller 16 is adapted to be engaged by the hereinbefore described annular cam formed upon the rotative field magnet hub 1. The smooth depressed cam surfaces *a* and *b*, which are in the same plane, as hereinbefore noted, do not press upon the projecting cam roller 16 but preferably permit the cam roller to have a certain amount of play and looseness, thereby permitting the circuit-closing spring 11 to maintain the closed circuit condition. However, the rounded cam projections *c* and *d* successively strike against or engage the cam roller 16 and force it back in its containing slot, thereby imparting circuit-breaking movement to the lever bar 12 against the tension of the circuit-closing spring 11. These cam projections *c* and *d* only break the circuit momentarily, permitting it to be immediately again closed by the circuit-closing spring 11.

As hereinbefore described, the first or circuit-clearing cam projection *c* rids the circuit of disturbing currents and leaves it free for the production of the succeeding spark-producing current impulse, the circuit of which is broken by the second or spark-producing cam projection *d* at the proper point of current flow to produce the most effective spark, as hereinbefore described. Because of the fact that the circuit-breaking cam roller 16 is loose within its containing slot at all times excepting when momentarily engaged by these cam projections *c* and *d* the wear upon this cam roller and upon the adjacent end of the lever bar 12 and upon other coöperative parts is very slight and is much less than it would be were the circuit maintained in a normally open condition by an extended projecting cam surface such as has hereinbefore commonly been the practice. Also in this connection it is to be noted that the advance breaking of the circuit at a non-sparking point by the circuit-clearing cam projection *c* produces improved electrical effectiveness comparable to that produced by a construction providing for operation under the normally open circuit system.

It is to be noted and is to be understood that the circuit-breaking cam projections *c* and *d* do not necessarily need to be relatively located exactly at the positions shown in the drawings. The first or circuit-clearing cam projection *c* could be shifted circumferentially somewhat relatively to the spark-producing cam projection *d* and good results still be secured. However, the circuit-clearing cam projection *c* should be so located as to avoid the production of a spark as that would be objectionable, in that it would unnecessarily deteriorate the spark plug 5 and also might sometimes effect pre-ignition. The best results so far have been secured by the location of the first or circuit-clearing cam projection *c* and the second or spark-producing cam projection *d* ninety degrees or one-fourth of a rotation apart, as illustrated in the drawings. It is to be understood of course, that the rotative cam-carrying hub 1 must be properly timed with relation to the magneto armature, which, in the construction illustrated in the drawings, is stationary. A condenser 17 is shown as connected across the contact terminals 6 and 14 of the circuit-breaker in the usual way as is well understood in the art.

In the magneto construction embodying my invention illustrated in the drawings, the cam-carrying hub 1 is also the hub of the fly wheel of the engine and is shown as removably held, by means of a tap bolt 18, upon the outer end of the engine crank shaft 19. This outer end of the crank shaft 19 is shown as journaled, by means of ball bearings, in a bearing ring or collar 20 which is screw-threaded over the adjacent outer end of a stationary sleeve 21. The armature hub 8 is fixed upon the stationary collar 20 so that the magneto armature is stationary while the field is rotative, being carried by the fly wheel hub 1. In the construction of magneto illustrated in the

drawings, a combined fly wheel shell and magnet carrier 22, preferably of non-magnetic material, such as brass, is fixed upon the cam-carrying hub 1 and has a peripheral flange or rim, as appears in the drawings. The field magnet of the magneto is shown as comprising two semi-circular permanent magnets 23 which have their like poles in contact and which fit within the peripheral flange or rim of the fly wheel shell 22 and are carried thereby. These semi-circular magnets 23 are provided at their joined ends with curved oppositely arranged polar extensions or poleshoes 24, as most clearly appears in Fig. 5.

It will now be readily understood that the magnets 23 and their pole shoes 24 provide two opposite magnet poles and also that the straight or bar-like armature core 10 is similarly bipolar. In this construction, as will be clear from an inspection of the drawings, particularly Fig. 5, there will be two alternating current impulses for each rotation of the rotative field, and one of these current impulses will have its maximum strength substantially in the relative position of the rotative parts appearing in Fig. 5 of the drawings, and this maximum current impulse is that which is indicated in Fig. 3 as occurring at 270° of rotation, this being the unused current impulse whose after effects are dissipated by the advancing circuit-clearing cam projection *c* at a point ninety degrees in advance of the breaking of the circuit at substantially the point of maximum current strength of the next succeeding current impulse by the following spark-producing cam projection *d* which, as hereinbefore noted, breaks the circuit at the point indicated in Fig. 3 at 90°.

In the construction illustrated in the drawings a plate-like stationary frame part 25 of the self-propelled vehicle is shown as held in place on the stationary sleeve 21 by the stationary armature-carrying bearing collar or ring 20. Also a ground wheel of the vehicle has a hub 26 shown as journaled upon the sleeve 21.

It is obvious that various modifications may be made in the construction illustrated in the drawings and above particularly described within the principle and scope of my invention.

I claim:

1. A magneto having, in combination, a short circuited primary coil, a secondary spark coil in inductive relation with the primary coil, means for producing alternating current in the short circuit of the primary coil, and means for breaking such short circuit at a non-sparking time in relation to the current therein and also for subsequently breaking such short circuit at a spark-producing time in relation to such current.

2. A magneto having, in combination, an armature including a short circuited primary coil and a secondary coil, a field magnet, the field magnet and the armature being mounted for relative rotation, and means operated by the relative rotation of the field and armature for successively breaking such short circuit at non-sparking and at spark-producing points in such rotation.

3. A magneto having, in combination, two relatively rotary parts, a short circuited primary coil, a secondary spark coil in inductive relation with the primary coil, and means operated by such relative rotation for successively breaking such short circuit at a non-sparking and at a spark-producing point in such rotation.

4. A magneto, having, in combination, two relatively rotary parts, a short circuited primary coil, a secondary spark coil in inductive relation with the primary coil, and means operated by such relative rotation for successively breaking such short circuit at a non-sparking point preceding a spark-producing point and again at the next succeeding spark-producing point.

5. A magneto having, in combination, two relatively rotary parts, a short circuited primary coil, a secondary spark coil in inductive relation with the primary coil, and means operated by such relative rotation for breaking such short circuit successively substantially at points of minimum and of maximum current flow.

6. A magneto having, in combination, an automatically acting circuit-closing circuit closer, and circuit-breaking means for operating the circuit closer to break the circuit, such means including a cam for thus operating the circuit closer to break the circuit at a time of substantially maximum flow of current for producing a spark and at a preceding time of less flow of current for clearing the circuit.

7. A magneto, having in combination, a spring-pressed circuit closer, and circuit-breaking means coöperative with such circuit closer, such means including a cam having a spark-producing circuit-breaking cam projection and also having a circuit-clearing circuit-breaking cam projection.

8. A magneto having, in combination, a primary coil included in a normally closed circuit, a secondary spark-producing coil in inductive relation with the primary coil, and means for alternately breaking the circuit of the primary coil at a point to clear the circuit and at another point to produce a spark at *successive alternate breakings* of the circuit.

9. A bipolar magneto having, in combination, a primary coil included in a normally closed circuit, a secondary spark-producing coil in inductive relation with the primary coil, spark-producing circuit-break-

ing means operative to break the circuit of the primary coil at a bipolar point substantially when the flow of current is greatest, and circuit-clearing circuit-breaking means operative to break the same circuit after the subsidence of maximum current flow in the opposite direction corresponding to the other bipolar point.

10. A magneto having, in combination, a primary coil included in a normally closed circuit, a secondary spark-producing coil in inductive relation with the primary coil, spark-producing circuit-breaking means operative to break the circuit of the primary coil at alternate points of substantially maximum current flow, and circuit clearing circuit-breaking means operative to break the same circuit at other alternate points after the subsidence of maximum current flow.

In testimony whereof I have affixed my signature.

GEORGE W. WACKER.

J. G. HEASLET.

SPARK CONTROL IN COMBUSTION ENGINES.

APPLICATION FILED AUG. 13, 1915.

1,239,689.

Patented Sept. 11, 1917.

4 SHEETS—SHEET 1.

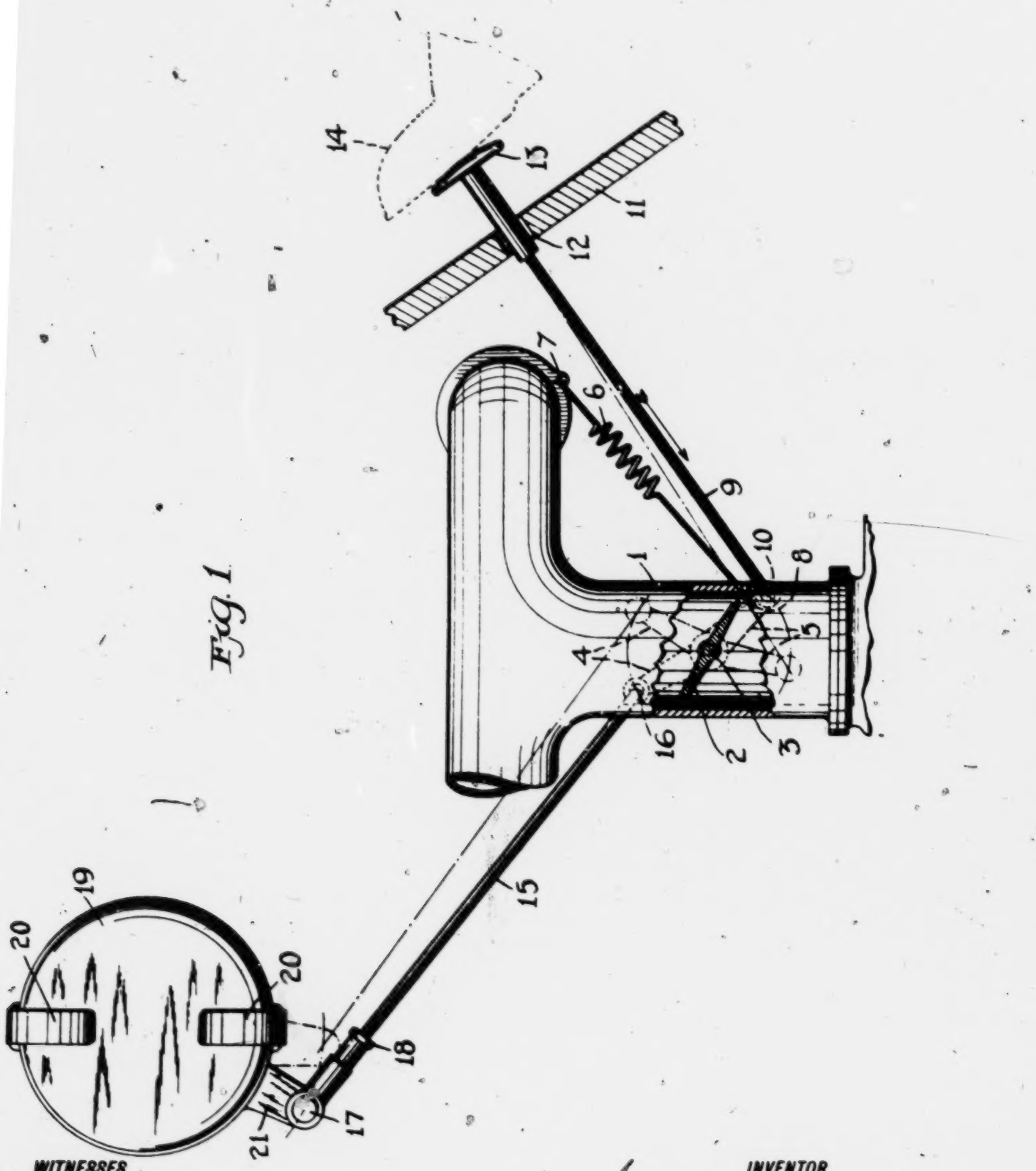

Fig. 1

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4 SHEETS—SHEET 2.

Fig 2.

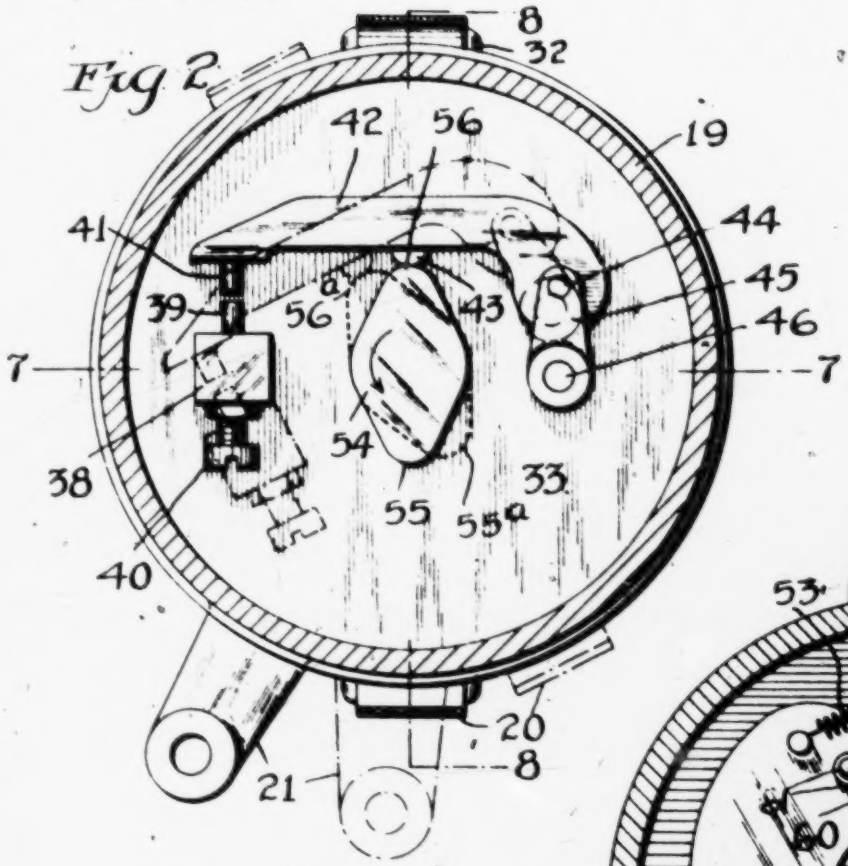


Fig 3.

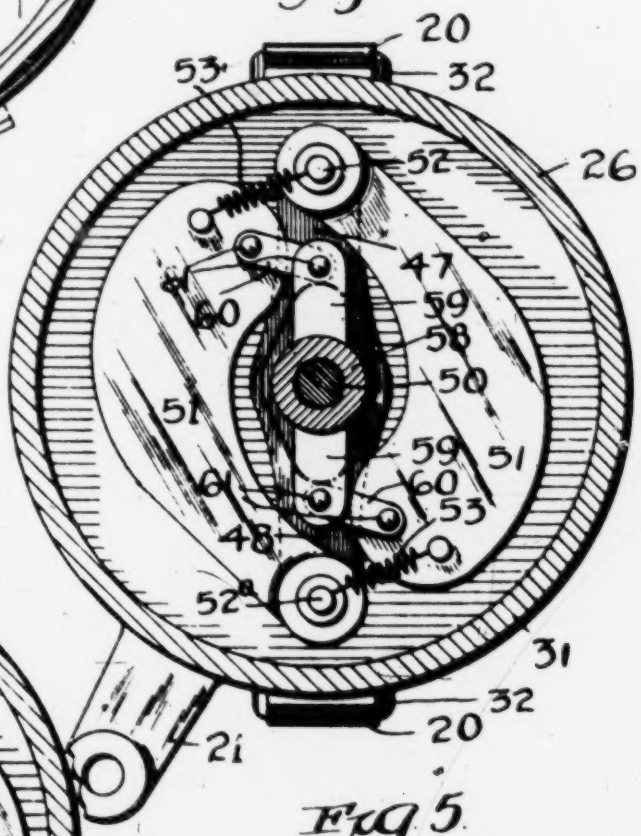


Fig 4.

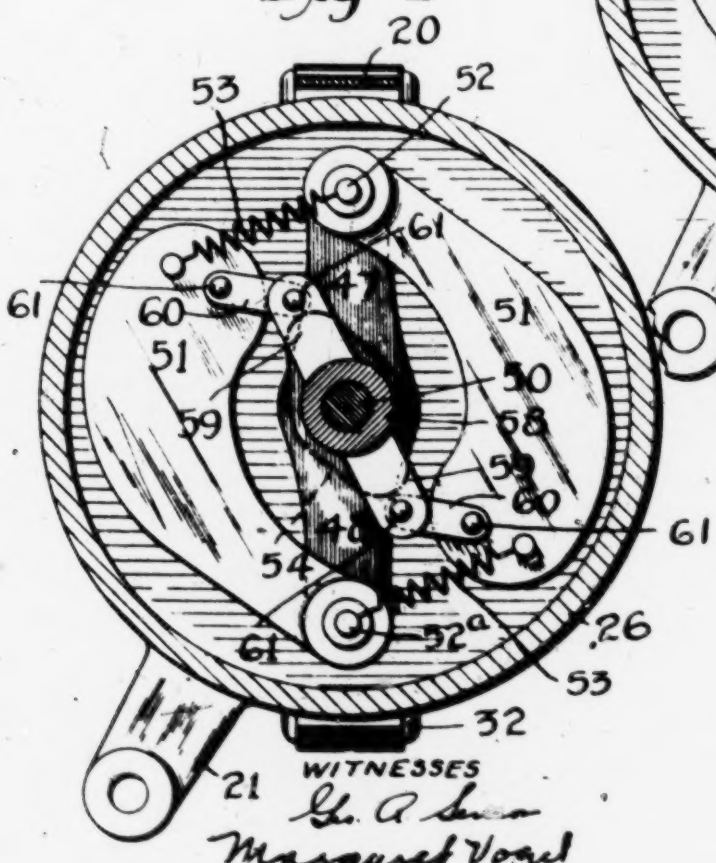
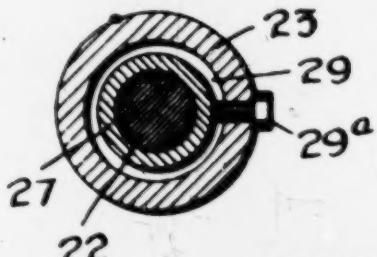


Fig 5.



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4 SHEETS—SHEET 3.

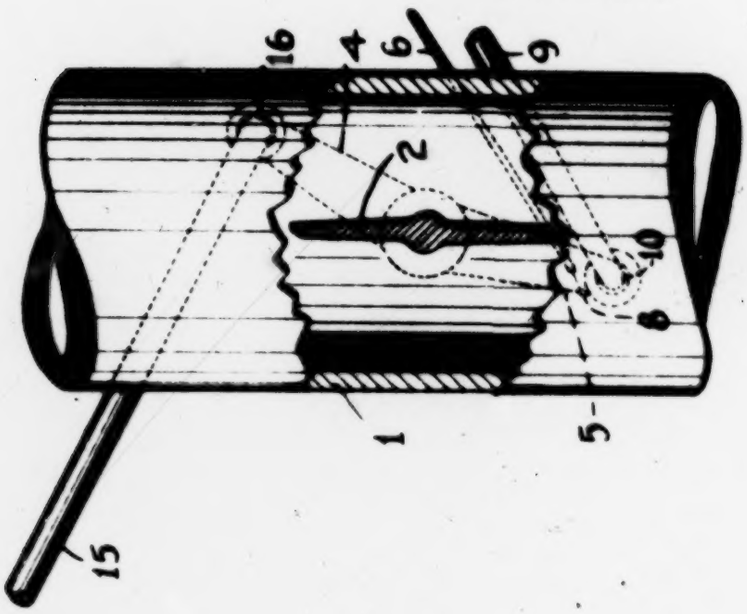
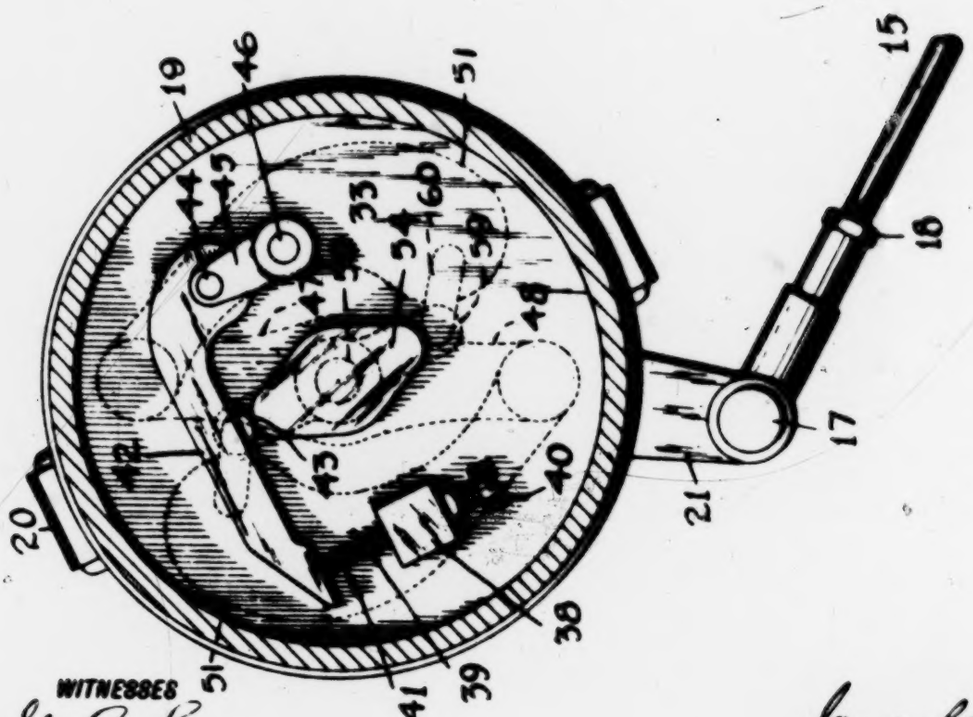


Fig. 6.



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4 SHEETS—SHEET 4.

Fig. 8

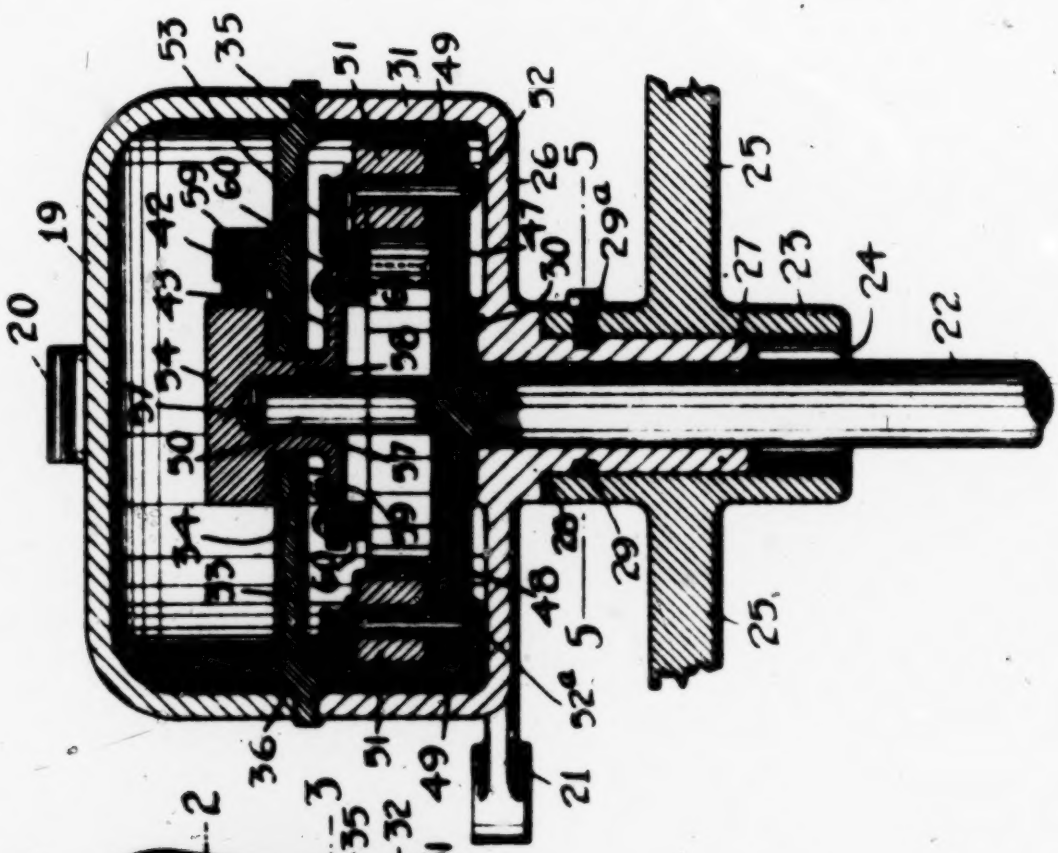
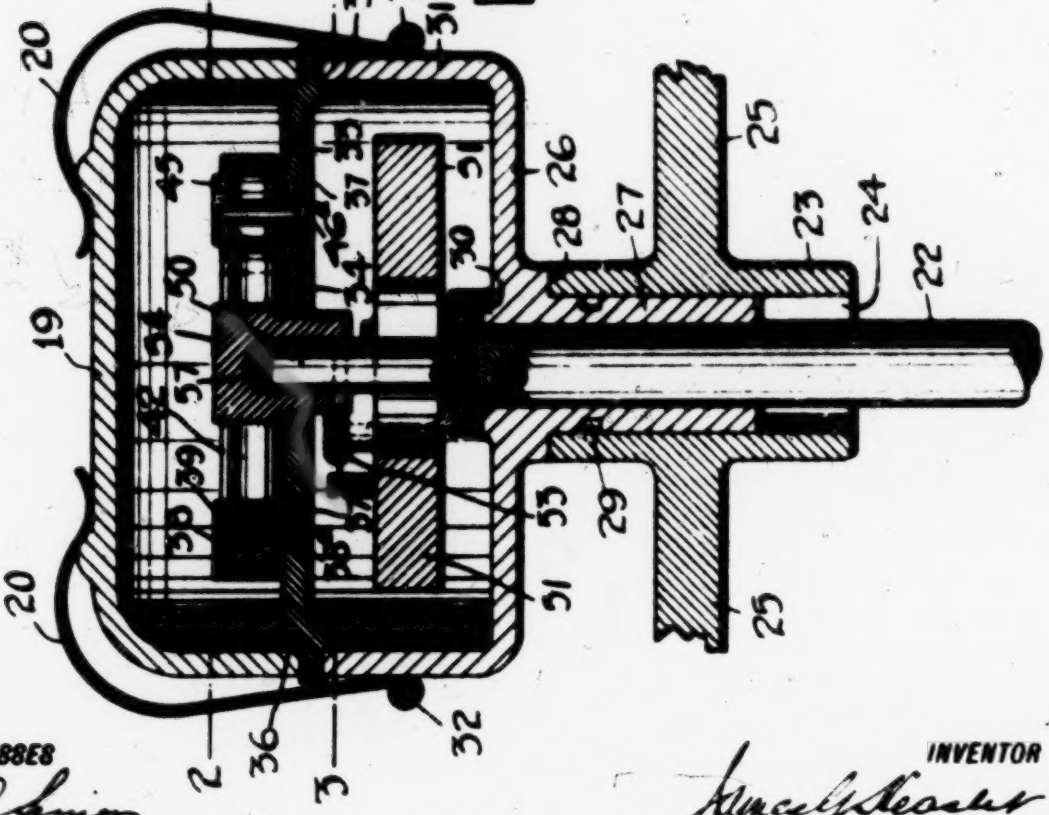


Fig. 7



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SPARK CONTROL IN COMBUSTION-ENGINES.

1,239,689. Specification of Letters Patent. Patented Sept. 11, 1917.

Application filed August 13, 1915. Serial No. 45,290.

To all whom it may concern:

Be it known that I, JAMES G. HEASLET, a citizen of the United States of America, and resident of Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Spark Controls in Combustion-Engines, of which the following is a specification.

This invention relates to an improvement in means for controlling the throttle and spark-producing means in the operation of internal combustion engines.

In the operation of such engines, it is desirable, under certain conditions of load and speed and fuel supply to advance the spark so as to cause an explosion of gas in anticipation of the completion of the piston stroke. This is accomplished manually, usually by the hand or foot of the operator, resulting in the displacement of what is known as the "timer" from a zero position where the spark is generated at or adjacent to the full thrust of the piston, to a position where its contact with the controller operates to produce the spark at a point before the piston completes its stroke. The same result is also accomplished by automatic means, dependent upon the speed at which the motor is rotating, such apparatus being adjusted to advance the spark in proportion to the increase of motor speed.

Such spark-controlling devices are usually adjusted and operated most efficiently under conditions where a limited volume of gas and air sufficient for normal road conditions is supplied to the motor. I have observed, however, that when a greater volume is supplied to the motor than the limited volume above referred to, to meet abnormal road conditions and where the spark is still advanced, the resultant phenomena is a pounding of the engine, due to conditions which are well understood in the operation of such motors. Such pounding can, however, be avoided by retarding the spark in anticipation of, or at the time, that a greater volume of gas is supplied to the motor, but, in order to accomplish such retardation of the spark with the increase of gas volume, it is necessary (or it has heretofore been necessary) to change the adjustment of the spark-controlling means, be the same manual or automatic, such change necessitating the readjustment of the spark-control when the volume of gas supplied is again restored to the normal minimum volume.

The object of my invention is to provide means, operating in unison with throttle mechanism, whereby the spark controlling mechanism will be subject to throttle control mechanism, when and after the throttle is opened to supply combustible fluid to the motor in excess of a predetermined volume, without however disturbing the setting or adjustment of either manual or automatic spark controlling means employed when a less volume than that referred to is admitted to the motor. My object being to retard the spark when an abnormal volume of gas is supplied to the motor to meet conditions of engine load, and to restore the spark to its setting under manual, or adjustment under automatic spark control, w'-n the volume of gas supply is again reduced to a normal and predetermined volume.

I accomplish these results as follows:— Sparking mechanisms comprise two elements, a timer and a spark controller, mounted in such relation that the timer engages the spark controller in the course of its revolution, thus causing the breaking of the circuit and the resultant spark. The timer is adjustably mounted to turn on its axis, and the manual or automatic control above referred to comprises the moving of the timer on such axis and, by so doing, determining the point in the arc of its rotation at which it will engage the controller. Heretofore the controller has been mounted in a stationary position. In the present embodiment of my improvement I mount the controller so that it may be rotated for purposes of adjustment in the same arc as that in which the timer moves, to the end that I may adjust the position of the timer in its relation to the controller, or the position of the controller in its relation to the timer. In the embodiment of my invention here disclosed, I show the timer under automatic control, regulated according to the speed of engine rotation. On the other hand, I place the controller under the control of means operating either by or in unison with the throttle control. It will be obvious,

therefore, that it is possible for me, under this construction, to neutralize the operation of either one of these controls by moving the other control in a direction to meet and compensate for the movement of the other member oppositely controlled, without interfering with or changing the adjustment of such control, that is to say, when the timer is advanced to a certain position by the manual or automatic control, and there maintained under predetermined conditions of speed and under conditions when a certain volume of gas is supplied to the motor (it matters not whether such control is mounted to operate either the timer or the circuit controller), it is obvious that if I move the other member in the arc of its movement, in the same direction and to the same extent as the timer has been previously moved, it will neutralize the effect of the movement of the timer and restore the point of their engagement to a zero position and thus retard the spark, the zero position in such case being understood to be the point at which the spark is caused to operate when the piston is at or adjacent to the limit of its thrust.

In the present embodiment of my invention is shown one means by which the results above referred to may be accomplished. I do not, however, intend to limit my claims to the present embodiment, for it will be apparent that other and different means may be employed to accomplish the neutralizing effect above described, provided such means operate to automatically retard the spark at, and after, a predetermined volume of gas is supplied to the motor, such means operating under the control, or operating in unison with the throttle, to cut out or automatically neutralize the effect of the normal spark-controlling means without changing the adjustment of such means.

I have illustrated my invention in the accompanying drawings, wherein Figure 1 is a diagrammatic view, partly in elevation and partly in section, showing a throttle and means to control the same, together with an elevation in plan view, of the device employed by me to accomplish the results above referred to. Fig. 2 is a plan view of the devices shown in section in Fig. 7, the same being taken on the line 2–2, that is to say, with the hood or cap 19 removed. Fig. 3 is a plan view of the devices shown in Fig. 7 on the line through 3, the apparatus in this drawing being shown in a zero or normal position. Fig. 4 is a duplicate of Fig. 3, showing the device in an abnormal position, that is to say, with the arms distended by the operation of centrifugal force. Fig. 5 is a horizontal section of Fig. 8 taken on line 5 5. Fig. 6 is a view of Fig. 2 showing the timer advanced and the controller also advanced to meet the same. This view also shows the throttle fully open. Fig. 7 is a vertical section of Fig. 2 on the line 7 7 with the hood or cap 19 in place. Fig. 8 is a similar vertical section to that of Fig. 7, taken on the line 8 8 of Fig. 2.

1 is a tube through which combustible fluid is supplied to the motor. It contains a butterfly valve, 2, which is mounted on shaft 3, the latter being journaled in the walls of the tube 1. On the opposite side of said tube 1 and secured to the shaft 3, as indicated in dotted lines in Fig. 1, is a bell crank lever having two arms, 4 and 5. 6 is a helicon spring secured at one end, as at 7, to a stationary member, and at the other end to the arm 5 of said bell crank lever at point 8, its tension being directed to hold the valve 2 normally closed. 9 is a rod with one end pivotally connected to the arm 5, and at the other end passing through a hole, 12, in the floor, 11. 13 is a pushbutton and 14 is the illustration of a human foot bearing on the same. 15 is a rod pivotally connected at 16 with the arm 4 of the bell crank lever referred to, and at the other end pivotally connected at 17 with an arm 21, the operation of which will hereafter be described. 18 indicates a screw adjustment by which the throw of the arm 15, in its relation to the arm 21, may be determined and adjusted.

Referring to Figs. 7 and 8, 25 is a suitable support for a sleeve, 23, the latter having a central aperture at 24, and a bearing surface, 28, at the top thereof. 26 is a casing provided with a stem, 27, and a shoulder adapted to rest on the bearing surface 28, said stem being provided with annular groove 29. The stem 27 is keyed to revolve within the sleeve 23 by the screw 29^a. Casing 26 has the bearing surface 30 and annular walls 31.

22 is the shaft mounted to be rotated in unison with motor revolution. It is adapted to be mounted within the stem 27, and is provided with a shoulder to rest on the bearing surface 30 of the casing 26. It is provided with the radial arms 47 and 48, and is further projected into the stem 50.

The springs 20 are attached to the walls of casings 26 at 32 and operate to hold cap 19 in position; interposed between the cap 19 and the walls 31 of the casing 26 is a partition or plate 33 having a central aperture 34 and screw holes 37, and an annular boss 35, to receive the walls 31 of the casing 26, and an annular boss 36 to receive the walls of the cap 19. 38^a and 46^a are screws adapted to secure the circuit controller in position on the plate 33.

Referring to Fig. 2, I there illustrate a timer and a circuit controller, the latter comprising the following elements: 38, is a post screwed to the plate 33 by the screw 38^a and carrying the electric contact point 39, which

is adjustable by set screw 40 in its relation with the electric contact point 41. 42 is an arm carrying the electric contact point 41, and also the physical contact point 43, which is adapted to engage either end of the timer 54. Arm 42 is pivoted at 44 to the link 45, which in turn is secured in a fixed position to the plate 33 by the screw 46.

Referring to Figs. 3, 4, 7 and 8, 47 and 48 are two arms, preferably integral with the shaft 22, and having their bearing on the surface 30 of the casing 26, the stem 50 rising intermediate said arms on the axis of the shaft 22. 51 and 51 are loaded levers pivotally connected to the arms 47 and 48 by the bolts 52 and 52 respectively. 53 and 53 are helical springs interposed between the ends of said levers and the bolts last referred to, having their tension directed to hold said weighted levers in the position shown in Fig. 3, whereas, under the exercise of centrifugal force they are thrown into the position shown on Fig. 4. 54, shown in full lines in the Fig. 2 is a timer, oval in form, the ends 55 and 56 mounted to engage the contact point 43 of the circuit controller. This timer is shown in dotted lines in Fig. 3, in its normal or zero position, and in dotted lines in Figs. 2 and 4 in its abnormal position, that is to say, when in its operation the spark is advanced. The timer 54 is internally bored, as at 57, such bore being adapted to receive the stem 50, and it is mounted within the aperture 34 in the plate 33. 58 I characterize as the neck of the timer, from which radiate two arms, 59—59. 60 and 60 are links interposed between the respective ends of the arms 59 and the weighted levers 51, such pivotal connection being accomplished by the bolts 61.

The operation of this device is as follows: Assuming that the automatic spark control, the operation of which will be presently described, is set to operate in conformity with a predetermined rate of motor revolution and under conditions where a predetermined volume of gas is supplied to the motor, these conditions satisfying the normal requirements of usage in the operation of automobiles, resulting in the satisfactory operation of the motor under normal conditions of load. (The operation of the device under abnormal conditions of load will be dealt with presently.) Under the normal conditions of load above referred to, the valve 2 is so adjusted that the movement of the valve by the pressure of the foot 14 on the button 13 will not operate to move the rod 15 until the valve is moved on its axis to points substantially as indicated in Fig. 1. In this position it will be noted that the valve is open and that a certain volume of gas, measured by the extent of such opening, is permitted to flow to the motor, this I characterize as a predetermined volume capable of being measured and regulated. The relation of such volume to the devices herein described is regulated according to the length of the stem 15 as controlled by the set screw 18. During the period that this predetermined volume of gas is flowing to the motor, the automatic control as herein described, or the manual control if such be employed, is undisturbed by the operation of mechanism presently to be described. Hence it may be said that during a period when a predetermined volume of gas is flowing into the motor, that is to say, a volume governed by the position of the valve 2, the motor is entirely in the control of the spark regulating means as at present employed and as well understood in the art. This operation is maintained during normal road conditions, as, for instance, where the machine is traveling over a level or approximately level road, thus presenting a uniform or approximately uniform load to the operation of the motor. Under these conditions, the spark may be, and usually is, advanced a predetermined degree, as the best results are obtained under such conditions.

The automatic spark control above described operates as follows: The shaft 22 is geared to operate in conformity with motor speed, and such operation causes the arms 47 and 48 to revolve about the axis of the shaft 22, of which they form a part. The weighted levers 51 and 51 are respectively pivoted at the ends of the arms 47 and 48 and bound thereto by the springs 53—53. The timer 54 is mounted on the stem 50 and its arms 59—59 are secured to the weighted levers by the links 60—60. Under normal conditions, when the engine is running slow, the elements last described are found in the position shown in Figs. 2 and 3. Under such conditions the timer 54 makes contact with the controller knob 43 at predetermined intervals in the course of its rotation, the adjustment being such as to produce a spark in the cylinder at a time when the piston is at or adjacent to its full thrust, this I characterize as the "zero position". However, as the speed of the rotation of the engine increases, the weighted levers 51, because of the power of centrifugal force exercised upon them, are distended against the tension of the spring 53 into or adjacent to the position shown in Fig. 4, thus operating to turn the timer 54 on its axis and bring the same, say, into the position shown in dotted lines in Figs. 2 and 4 and in full lines in Fig. 6. The operation of the timer under these conditions is to cause the spark to be produced in the cylinder in advance of the piston accomplishing

its full stroke, such relation being generally characterized as an "advance spark". The device just described is one of many forms of automatic spark control. The manual controller consists of any means operated manually to turn the timer 54 in like manner at the will of the operator.

Under the conditions which I have described, it is intended that the automatic control just described shall operate during the period that the throttle is in a position to deliver to the engine a predetermined volume of gas, as, for instance under conditions similar to those which I have graphically illustrated in Fig. 1, where the valve is shown partly open.

Suppose, now, an abnormal load is opposed to the operation of the engine, such, for instance, as an unusual grade, a sandy road or the like. Under these conditions, it is desirable, and in many cases necessary, to supply the engine with a greater volume of gas. As previously stated, if this greater supply of gas is fed to the engine while the spark is materially advanced, the engine begins to pound, due to well known phenomena not necessary here to enumerate, thereby losing efficiency and endangering the life of the motor. It is necessary, therefore, to immediately retard the spark, this can be done under conditions of manual control by turning the timer to zero, and, under conditions of automatic control, by slowing down the speed of the motor. Both of these operations are objectionable, for the reason that in the case of the manual control when the supply of gas again becomes normal, it becomes necessary to go through the operation of readjusting the spark to normal conditions, which requires skill and attention. Where automatic control is employed, it is undesirable, and sometimes impracticable, to slow down for the purpose of meeting the conditions described. Therefore, it becomes of the first importance to find means by which the spark may be retarded without interfering with such adjustments. I will now describe the manner in which I accomplish this result: Further pressure on the button 13 causes the valve to open to supply a volume of gas in excess of that supplied under normal conditions, and, as the valve 2 is opened by the pressure of the foot, the bell crank lever 4 is moved in the arc of the circle indicated in dotted lines in Fig. 1 and operates to move the rod 15 in the direction of the movement of the bell crank lever 4, and, in so doing, moves the arm 24 carrying with it the casing 26, which is mounted on the stem 27 to revolve in the sleeve 23, carrying with it plate 33 and the circuit controlling mechanism represented by the contact point 43 and electric contact points 39 and 41, all of which, as heretofore stated, are mounted on plate 33. This change of position is indicated in dotted lines in Fig. 2 and full lines in Fig. 6, where it will appear that, notwithstanding the fact that the timer 54 has been moved into a position to advance the spark, as shown in dotted lines Figs. 2 and 4, the fact that contact point 43 and its accompanying members have been moved in the arc of their mounting in the same direction (as shown in dotted lines Fig. 2 and full lines Fig. 6), operates to bring the point of engagement between them to the zero position from whence they started, and hence operates to neutralize the effect of the movement of the timer 54, thus retarding the spark during the period that the valve 2 is opened to admit a volume of gas in excess of that predetermined volume under which the automatic control is adjusted to operate, *i. e.* under normal conditions. When, however, the pressure of the foot is relieved from button 13 sufficiently to permit the valve 2 to be restored to its normal position in the power of the spring 6, casing 26, carrying the controller and the contact point 43 is again restored to its normal position, thus again advancing the spark to the position which it occupied prior to the opening of the throttle for the purpose of supplying an abnormal volume of gas.

Hence it will be apparent that the objects that I have in view, as heretofore stated, are accomplished by interposing a secondary spark control operating in unison with throttle control and adapted to neutralize the effect of a primary throttle control when a predetermined volume of gas is supplied to the motor, such volume being in excess of the volume employed during the operation of the primary spark controlling means.

What I claim is:

1. In an internal combustion engine, a throttle, and sparking mechanism, in combination with means operable by the throttle, only after the latter is opened beyond a predetermined extent, to control the sparking mechanism.

2. In an internal combustion engine, a throttle, and sparking mechanism, in combination with means operable by the throttle, only after the latter is opened beyond a predetermined extent, to retard the spark as the throttle is further opened and to subsequently advance the spark as the throttle is returned to the position of said predetermined extent of opening.

3. In an internal combustion engine, a throttle, and sparking mechanism, in combination with means operable by the opening and closing of the throttle for shifting the sparking mechanism to advance or retard the spark, said means being operable to control the sparking mechanism when the throttle is opened in excess of that necessary to supply a predetermined amount of gas to the motor, any operation of the throttle to

admit less than said predetermined amount of gas having no effect upon the sparking mechanism.

4. In an internal combustion engine, a throttle, and sparking mechanism, in combination with controlling means operated by the opening and closing of the throttle for controlling the sparking mechanism, said means being operable to control the sparking mechanism when the throttle is opened in excess of a predetermined maximum, under which maximum the operations of the throttle do not control the sparking mechanism.

5. In an internal combustion engine, a throttle, and sparking means, in combination with means, independent of the throttle, to control said sparking means during a period when the gas supply is limited by said throttle to a predetermined volume, with additional means to control said sparking means, the latter operating only when the gas supply exceeds the predetermined volume referred to as the limiting field of operation of the first-mentioned controlling means, the operation of said second controlling means being progressively to retard the spark as the volume of gas increases without interference with any manual or automatic adjustment of the first-mentioned spark controlling means.

6. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for simultaneously regulating both the throttle and the sparking means, said manual means being operable to regulate the throttle within a predetermined zone without effecting regulation of the sparking means.

7. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for simultaneously regulating both the throttle and the sparking means, said manual means being operable to regulate the throttle within a predetermined zone without effecting regulation of the sparking means, and means for automatically returning the throttle and sparking means to their initial conditions after being operated upon by said manual means.

8. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for separately controlling the throttle during a preliminary travel of the throttle, said manual means being also operable, upon a further throw of the throttle thereby, to simultaneously control the sparking means.

9. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for separately controlling the throttle during a preliminary travel of the throttle, said means being also operable, upon a further throw of the throttle thereby, to simultaneously operate the sparking means to retard the spark.

10. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for separately controlling the throttle during a preliminary travel of the throttle, said means being also operable, upon a further throw of the throttle thereby, to simultaneously operate the sparking means to retard the spark, and means for automatically returning the throttle to its normal position and simultaneously advancing the spark to its initial condition subsequently to the operation of the manually operable means.

11. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which embodies an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means operated by the opening and closing of the throttle for shifting one of said mechanisms relative to the other to advance or retard the spark synchronously with any change of adjustment of the throttle beyond a predetermined maximum opening.

12. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means for shifting the actuating means relative to the make and break device for advancing the spark, and means for subsequently shifting the make and break device relative to the actuating means to bring them into such relative positions as to retard the spark to normal.

13. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means for automatically shifting the actuating means relative to the make and break device for advancing the spark, and means, operable by the movement of the throttle, for shifting the make and break device relative to the actuating means to bring them into such relative positions as to retard the spark to normal.

14. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination

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with means for shifting the actuating means relative to the make and break device for advancing the spark, and means, operable upon the opening of the throttle beyond a predetermined point, for shifting the make and break device to the position which it initially occupied relative to its actuating means, for the purpose of retarding the spark to the same extent as said spark was advanced by the movement of the actuating means relative to the make and break device.

15. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means for shifting the actuating means relative to the make and break device for advancing the spark to a predetermined degree, during which operation the throttle may be opened to a predetermined maximum, at will, without having any effect upon the adjustment of the parts, and means operable upon the further opening of the throttle to shift the make and break device, relative to its actuating means, to the position which it initially occupied relative to its actuating means, for the purpose of retarding the spark to the same extent as said spark was advanced by the movement of the actuating means relative to the make and break device.

16. In an internal combustion engine, a throttle, and sparking means, in combination with manually operable means for simultaneously regulating both the throttle and the sparking means, said manually operable means being adapted to be operated at will up to a predetermined maximum degree of opening of the throttle, without effecting regulation of the sparking means, but adapted to retard the sparking means synchronously with the opening of the throttle beyond such predetermined maximum, and means, operating independently of the throttle, for automatically regulating the sparking means at such times as the throttle opening is equal to, or less than, the predetermined maximum opening referred to.

17. In an internal combustion engine, a throttle, and a sparking device comprising two coöperating mechanisms, one of which is rotatable in timed relation with the motor and adapted to actuate the other, which is normally stationary, for the purpose of periodically producing a spark, means for adjusting the position of the rotatable mechanism with reference to the normally stationary mechanism to advance the spark, and means for also advancing the normally stationary mechanism to the same extent as the rotatable mechanism is advanced to compensate for or neutralize the movement of the rotatable mechanism.

18. In an internal combustion engine, a throttle, and a sparking device comprising two coöperating mechanisms, one of which is rotatable in timed relation with the motor and adapted to actuate the other, which is normally stationary, for the purpose of periodically producing a spark, means for adjusting the position of the rotatable mechanism with reference to the normally stationary mechanism to advance the spark, and means for also advancing the normally stationary mechanism to the same extent as the rotatable mechanism is advanced to compensate for or neutralize the movement of the rotatable mechanism, said means for advancing the normally stationary mechanism being dependent for its operation upon the opening of the throttle beyond a predetermined maximum.

19. In a device of the class described, a shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, and means for shifting the normally stationary mechanism to retard the spark.

20. In a device of the class described, a shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, and means, operable by the throttle, for shifting the normally stationary mechanism to retard the spark.

21. In a device of the class described, a shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, and means for shifting the normally stationary mechanism, said means being operable by the throttle to retard the spark when said throttle is opened in excess of a predetermined maximum.

22. In a device of the class described, a

shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, and means for shifting the normally stationary mechanism, said means being operable by the throttle to retard the spark when said throttle is opened in excess of a predetermined maximum, any operation of the throttle, when the same is opened less than the predetermined maximum, having no effect on the spark control.

23. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means for shifting the actuating means relative to the make and break device for advancing the spark, and means for subsequently shifting the make and break device relative to the actuating means to bring them into such relative positions as to retard the spark.

24. In an internal combustion engine, a throttle, and sparking means, the latter embodying two coöperating mechanisms, one of which includes an electric circuit make and break device, and the other of which embodies means for periodically actuating said make and break device, in combination with means for automatically shifting the actuating means relative to the make and break device for advancing the spark, and means, operable by the movement of the throttle, for shifting the make and break device relative to the actuating means to bring them into such relative positions as to retard the spark.

25. In a device of the class described, a shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, manually controlled means for shifting the normally stationary mechanism to retard or advance the spark, and a throttle operable by said manually controlled means, said means being operable to open the throttle to a predetermined extent before shifting the normally stationary mechanism.

26. In a device of the class described, a shaft driven in synchronism with the power shaft of an internal combustion engine, a trip coöperating with said power shaft and rotatable therewith, normally stationary mechanism mounted adjacent the trip and operated thereby to periodically make and break the ignition circuit, means for varying the position of the trip relative to the piston stroke of the engine to advance the spark as the speed of the engine increases, manually controlled means for shifting the normally stationary mechanism to retard or advance the spark, a throttle operable by said manually controlled means, said means being operable to open the throttle to a predetermined extent before shifting the normally stationary mechanism, and means for automatically returning the stationary mechanism and manually controlled means to their normal conditions subsequently to the manual operation thereof.

27. In an internal combustion engine, a throttle, and sparking means embodying two elements, one of which is controlled by a governor, and the other of which is independent of the throttle up to the point of supplying a predetermined amount of gas to the engine, and controlled by the throttle only when said throttle is opened to supply an additional amount of gas to the engine.

28. In an internal combustion engine, a throttle, and sparking means embodying two coöperating mechanisms, one of which is controlled by the speed of the engine to automatically advance the spark with an increase in engine speed, and the other of which is controlled by the throttle after the throttle is opened beyond a predetermined maximum to neutralize the advance of the spark by the former mechanism, said throttle operating within the predetermined maximum independently of the sparking means.

29. In an internal combustion engine, a throttle, and sparking means embodying two mechanisms, one of which is controlled by a centrifugal governor to advance the spark with an advance in engine speed, and the other of which is controlled by the throttle only after said throttle is opened beyond a predetermined extent to neutralize the advance of the spark by the first mechanism.

Signed by inventor at Detroit, Michigan this 10th day of August 1915.

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GAS ENGINE.

APPLICATION FILED JAN. 5, 1914.

1,242,985.

Patented Oct. 16, 1917.

3 SHEETS-SHEET 1.

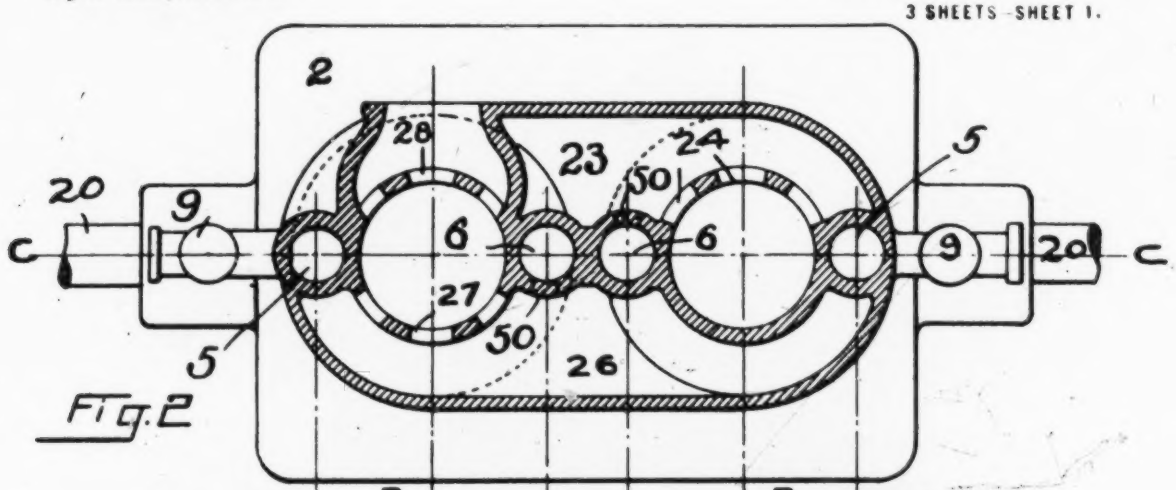

Fig. 2

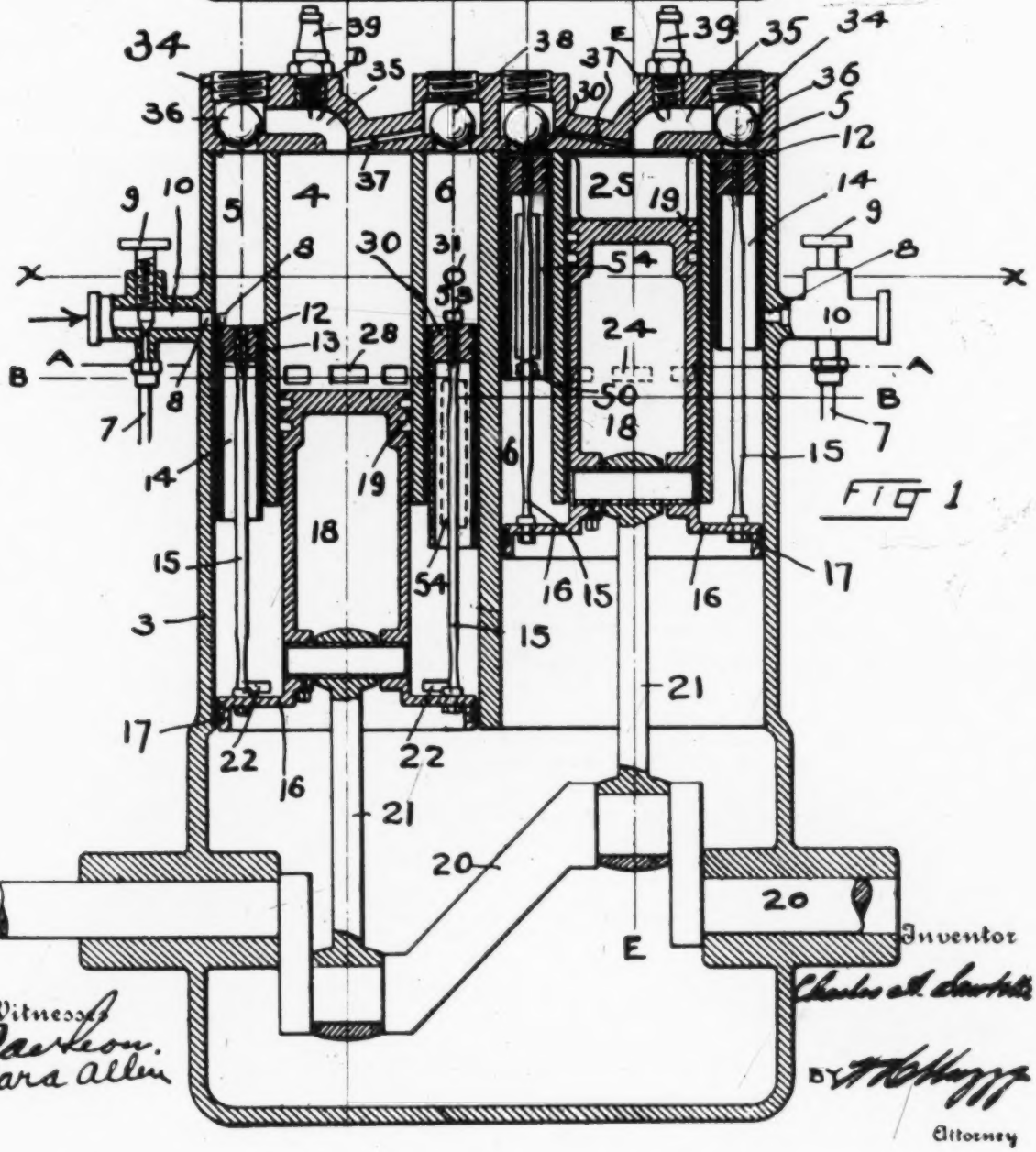

Fig 1

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Patented Oct. 16, 1917.

3 SHEETS—SHEET 2.

Fig. 3

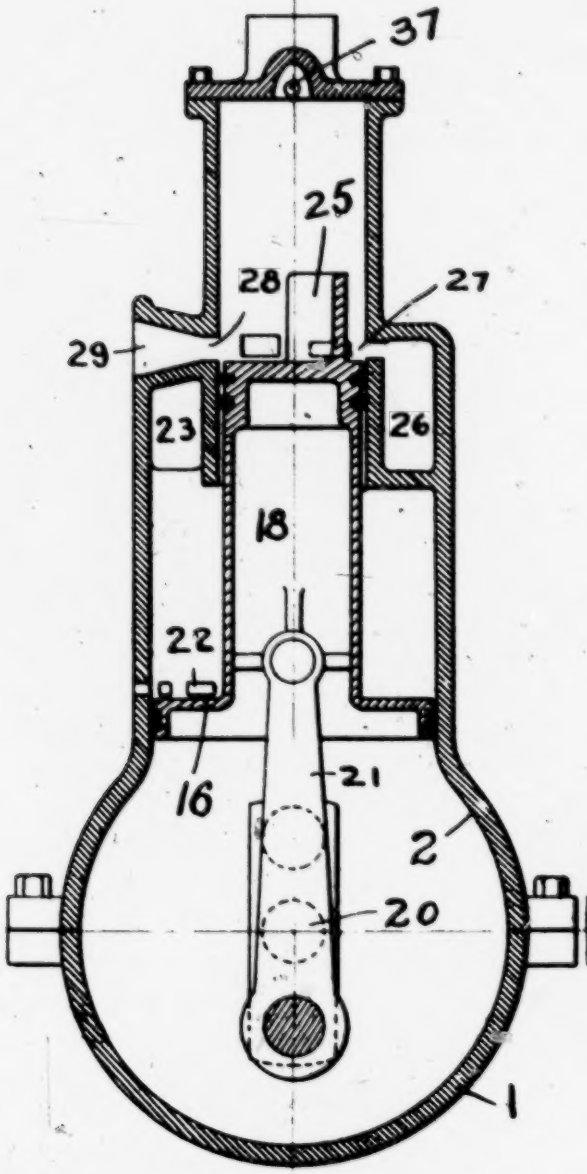
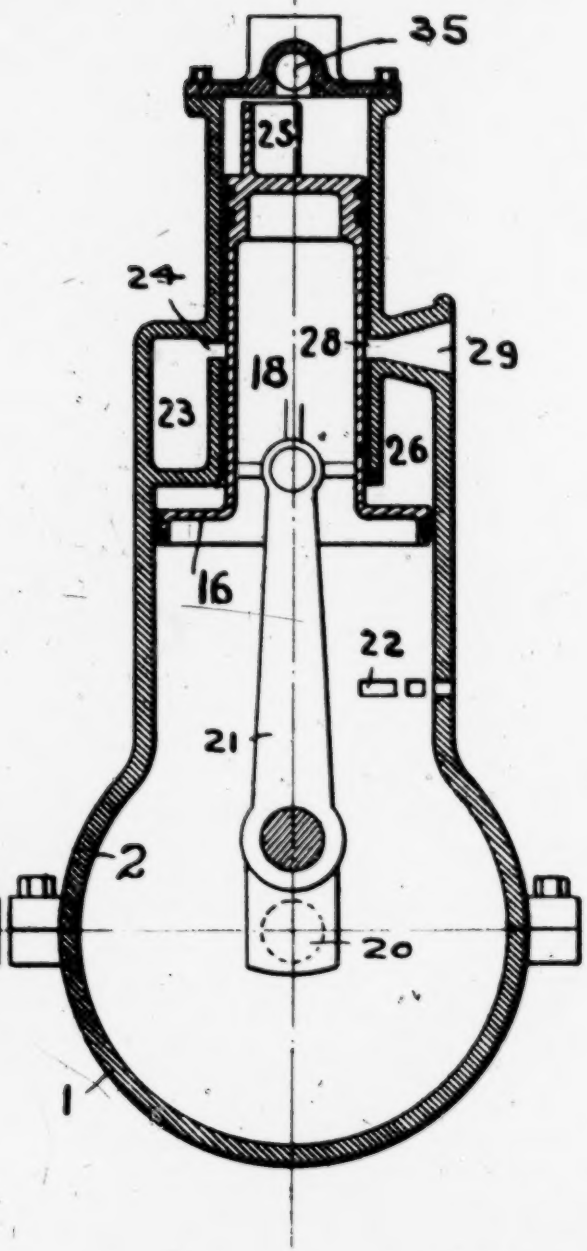


Fig. 4



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1,242,985.

Patented Oct. 16, 1917.

2 SHEETS SHEET 3.

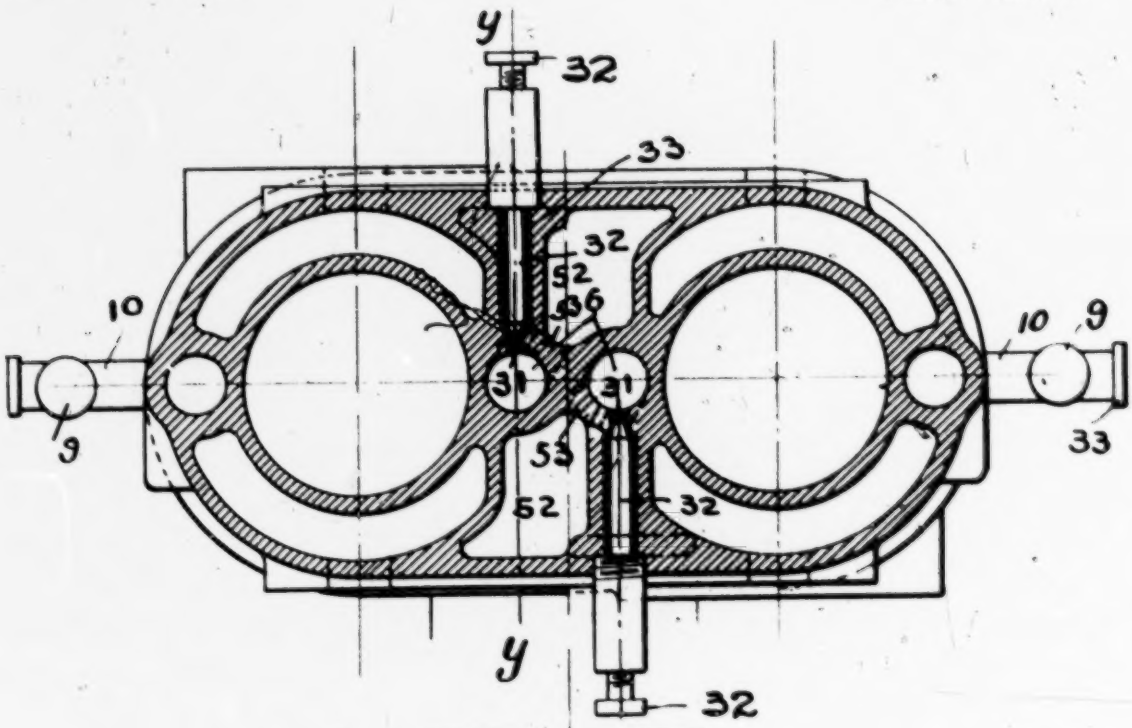

Fig. 5

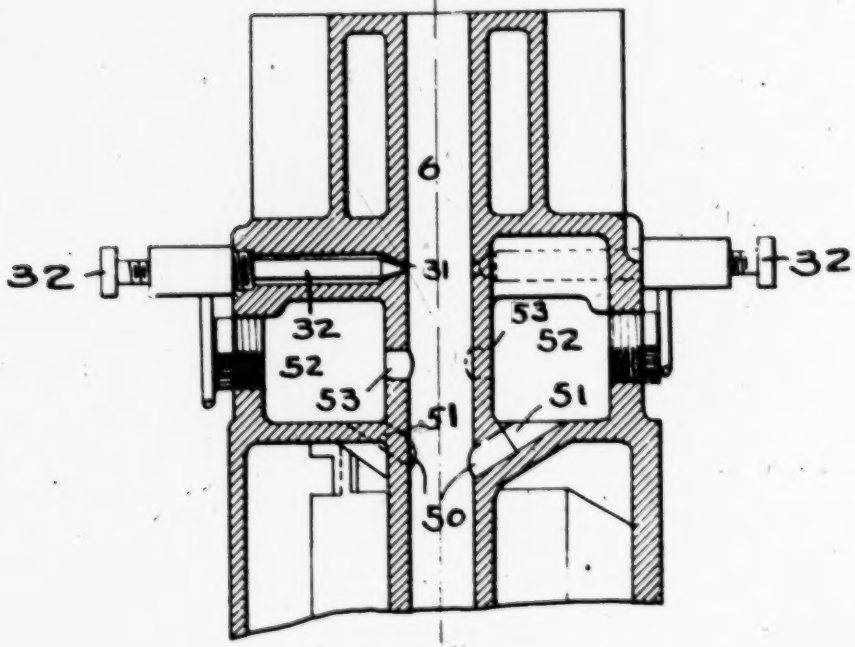

Fig. 6

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UNITED STATES PATENT OFFICE.

CHARLES A. SAWTELLE, OF DAYTON, OHIO, ASSIGNOR TO VINCENT G. APPLE, OF DAYTON, OHIO.

GAS-ENGINE.

1,242,985. Specification of Letters Patent. Patented Oct. 16, 1917.

Application filed January 5, 1914. Serial No. 810,297.

To all whom it may concern:

Be it known that I, CHARLES A. SAWTELLE, a citizen of the United States, residing at Dayton, in the county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Gas-Engines, of which I declare the following to be a full, clear, and exact description.

This invention relates to improvements in gas engines and has more particular relation to improvements in gas engines designed for burning of low grade fuels.

One of the principal objects of the invention is to provide a more efficient, reliable and more easily started gas engine adapted for use with a low grade fuel such as kerosene.

A further object is to provide an improved construction for securing more certain and reliable ignition in a gas engine.

A further object is to provide improved means for feeding compressed air together with the fuel into the engine.

With these and incidental objects in view the invention consists of certain novel constructions, combinations and arrangements of parts all of which will be hereinafter more particularly set forth and claimed.

While the invention is susceptible of numerous modifications in the construction and arrangement of parts, the preferred embodiment of the invention is illustrated in the accompanying drawings forming part of this specification and in which:

Figure 1 represents a vertical longitudinal section through the devices embodying the invention on the line C—C of Fig. 2;

Fig. 2 represents a longitudinal horizontal section through the engine half on the line A—A and half on the line B—B of Fig 1.

Fig. 3 represents a vertical transverse section through the engine on the line D—D of Fig. 1;

Fig. 4 represents a similar section on the line E—E of Fig. 1.

Fig. 5 represents a section similar to Fig. 2 but taken higher on the line X—X of Fig. 1, and

Fig. 6 represents a detail vertical section partly broken away on the line Y—Y of Fig. 5.

For the sake of illustration I have shown in the accompanying drawings, a two cylinder, two cycle type of engine with jump spark ignition but it will of course be understood that a number of the features of my invention are not limited to the two-cycle type of engine but can with equal facility be applied to any other type of gas engine, such for instance as the four cycle type.

In the aforesaid drawings 1 represents the lower half of the crank case of the engine; 2 the upper half of the crank case which is formed integral or cast "*en bloc*" with the cylinder sets. Each of these latter comprises an air cylinder 3, a gas explosion cylinder 4, and auxiliary charging cylinders 5 and 6; the former communicating with a gasolene supply through pipe 7 and port 8. A needle valve 9 is mounted in a short pipe 10 which communicates with port 8 at one end and is partly open to the air at the opposite end.

In each cylinder 5 is mounted a piston 12 provided with piston rings 13 and a pendant sleeve 14 which snugly fits the walls of the cylinder 5 and closes the ports 8 which open into pipe 10 at all times except when piston is in its lowermost position as shown in 1, when the ports 8 are uncovered.

Each piston 12 is connected by a rod 15 to its respective piston 16 having rings 17 and mounted in its air cylinder 3. Each rod 15 is reduced near its opposite ends so that it may have a certain amount of spring to accommodate any slight misalinement between the pistons 12 and 16.

The air piston 16 in each instance is formed with a reduced extension 18 which forms the main piston and which is provided with piston rings 19 and operates in the main explosion cylinder 4. Each piston 16 is connected to the crank shaft 20 by a pitman rod 21 in the usual manner.

Air ports 22 are formed in the walls of the cylinders 2 and are uncovered when the pistons 16 are in their lower positions as shown in the left hand cylinder of Fig. 1.

When the left piston 16 moves upward the pure air above it is compressed or forced into passage way or air space 23 shown in Figs. 2 and 3 and which is formed in the casting of the cylinders. It will be seen from an inspection of these figures that the passage 23 leads longitudinally from the air compression space of one cylinder 16 and discharges through ports 24 above the piston 18 of the opposed set when this latter piston is in its lower position.

Each piston 18 carries the usual baffle plate 25 so that when the air is admitted through ports 24 it is directed upward and whirling about the cylinder 4 scavengers this cylinder and blows out the burnt gas and at the same time charges it with fresh air.

The right hand air piston 16 forces air through passages 26 and ports 27 to scavenger the left hand cylinder 4 as shown in Figs. 2, 3 and 4.

The spent gases in each cylinder pass out through exhaust ports 28 and passages 29 on opposite sides of the engine.

Each of the cylinders 6 has a piston 30 similar to the pistons 12 and each piston is connected to its respective air piston 16 in the same manner as the pistons 12. These cylinders 6 however have ports 31 which are controlled by needle valves 32 mounted in passages 33 which are connected with the low grade fuel supply as shown in Fig. 6.

As best shown in Figs. 1 and 6 each of the cylinders 6 is formed with a port 50 which opens into a passage 51 which in turn connects with passage or chamber 52 in the casting of the engine. The passage 52 crosses over and connects with the opposed cylinder 6 by a port 53 as shown in Fig. 6, part of the air compressed by the piston 16 of one set passing through an elongated slot 54 formed in its respective piston 30, through port 50, passage 51, passage 52 and port 53 into the cylinder 6 of the other set.

It will be seen that the port 53 is below the port 31 so that as the piston 30 moves downward it first uncovers the port 31 and draws a charge of low grade fuel into the cylinder; then uncovers port 53 which admits the compressed air and thoroughly breaks up the charge of fuel. The cylinder 6 is thus entirely filled and the gas is under slight compression before the piston 30 starts upward. This results, when the piston moves up in the gases from the cylinders 6 having a slight lead on the gases from the cylinders 5 and tends to first fill the cylinders 4 with the low grade fuel and leave the high grade fuel in the passage 35 about the sparking points which are located well back in the passage as shown and away from the low grade gases.

The head 34 of each cylinder 4 is formed with a passage 35 connecting its respective cylinders 4 and 5; a ball valve 36 resting on a valve seat closes one end of passage 35.

A passage way 37 of much smaller diameter than 35 connects each passage 35 and its cylinder 6; a ball check valve 38 closing one end of this passage.

The area of each passage 35 is sufficiently large and is such in relation to the area of its cylinder 5 that the high grade fuel fed from the said cylinder tends to remain in the passage rather than be forced into the cylinder 4 as the gases from contracted passage 37 do.

Spark plugs 39 are arranged in the passages 35 and are connected to suitable electric sparking devices which form no part of the present invention.

After a cylinder 5 has been filled with a rich explosive mixture of gasolene and air by the downward movement of its piston 12 the charge is then compressed and forced into passage 35 first lifting the ball valve 36. The passage 35 is thus filled with a very explosive mixture only part of which has been forced into the cylinder 4. At the same time that this operation is taking place the piston 30 has compressed the charge of low grade fuel in the cylinder 6 and this charge lifting the valve 38 passes through the small passage 37 into the discharge end of the passage 35 and from there into the cylinder 4. The ball valves 36 and 38, it will be understood, prevent the air or gases from the cylinders 4 from passing into the cylinders 5 and 6.

By referring to Fig. 1 it will be seen that the pistons 12 and 30 are located higher than the piston 18 and that the throw of the crank shaft is such that very little compression space is left above these pistons 12 and 30 while the space above the piston 18 is considerably greater. As the pistons move up together the gas is thus forced from the cylinders 5 and 6 into the cylinder 4 as the pressure becomes greater in the two former cylinders.

From the foregoing description it will be seen that the explosion or power cylinders 4 have both a low and high grade fuel fed to them which results in an explosive mixture but one which might not readily ignite from the jump spark alone but which will ignite from the large and hot flame of the rich exploding gas in the passage 35.

An engine constructed as above is capable of running on a very low grade of fuel and of being readily started thus overcoming many of the objections of the present types of low-grade-fuel engines.

After the engine is started and warmed up the feed of the high grade fuel through the cylinder 5 may be cut down or in some cases cut entirely off but the preferable operation is to run with both cylinders 5 and 6 feeding fuel.

The compressed air fed to the cylinders 6 can be controlled by any suitable form of cock or valve (not shown) to secure a richer or weaker mixture in cylinders 6 as desired. The introduction of compressed air in the cylinders 6 after the introduction of the fuel results in a complete breaking up of the particles of low grade fuel and as a matter of fact starts an immediate feed of the low grade fuel into the cylinders 4. The opening of the ports 24 and 27 however is slightly

in advance of the opening of the ports 53 to secure a thorough scavenging of the cylinders 4 before any gas enters from the cylinders 6.

The high grade fuel is ignited without being appreciably weakened by admixture with the low grade fuel. This is possible as the spark plugs 39 are located well up in the passages 35 and as the gases are passing through these passages toward the cylinders and assisting in forcing the gases entering through the passages 37 downward into the cylinders. Further the passages 37 are inclined slightly downward so as to discharge into the very ends of the passages 35 and thus prevent any of the inferior gases passing up into these latter passages far enough to reach the plugs 39.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. In a gas engine the combination with the main cylinder and piston, of independent cylinders and pistons both feeding to the main cylinder, a carbureter device for each of the independent cylinders whereby they receive gas charges on their suction strokes and feed high and low grade gas to the main cylinder and igniting devices for igniting a portion of the high grade gas before it reaches the cylinder and mixes with the low grade gas.

2. In a gas engine the combination with a main cylinder and piston, of auxiliary cylinders and pistons, the latter directly connected for movement with the main piston, and connections for causing said auxiliary cylinders and pistons to feed high and low grade fuels respectively to the main cylinder.

3. In a gas engine the combination with a main cylinder and piston, of a low grade fuel feeding device connected to the cylinder by a passage of restricted area and a high grade fuel feeding means connected to the cylinder by a passage of relatively larger area and sparking devices in the large area passage.

4. In a gas engine the combination with a main cylinder and piston, of an auxiliary low grade fuel cylinder and piston connected to the main cylinder by a passage way, a high grade fuel feeding cylinder and piston connected to the main cylinder by a passage relatively larger than the passage first mentioned and ignition devices in the larger passage for firing the high grade fuel before it mixes with the low grade fuel.

5. In a gas engine the combination with a main cylinder and piston, of auxiliary cylinders and pistons for high and low grade fuels respectively connected to and moving with the main piston and connections between the auxiliary cylinders and main cylinder of such restricted area as to cause the contents of the auxiliary cylinders to feed into and be compressed in the greater compression area in the main cylinder.

In testimony whereof I affix my signature in the presence of two witnesses.

CHARLES A. SAWTELLE.

Witnesses:

VINCENT G. APPLE,

CLARA ALLEN.

C. F. KETTERING & W. A. CHRYST.

IGNITION SYSTEM.

APPLICATION FILED APR. 3, 1916.

1,265,454. Patented May 7, 1918.

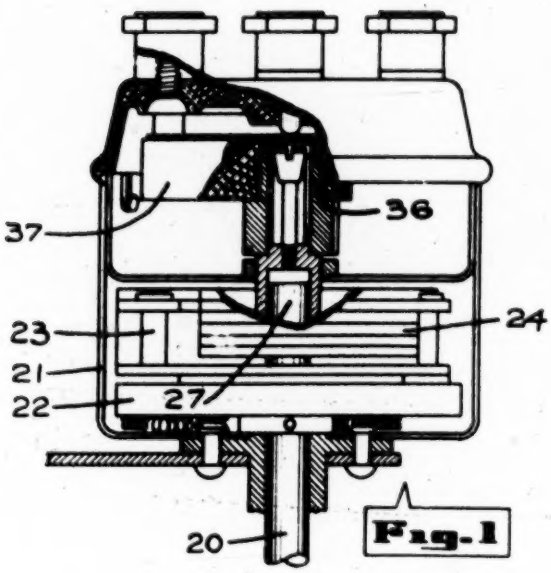

Fig. 1

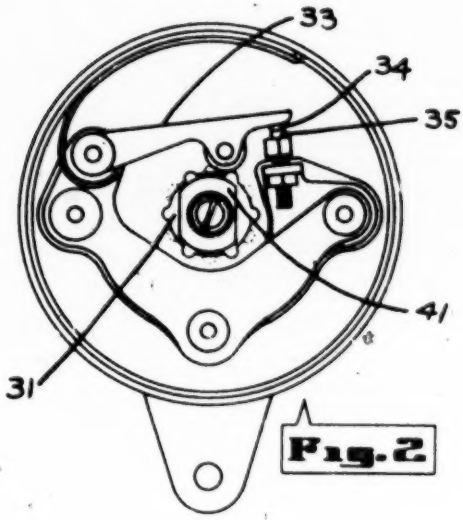

Fig. 2

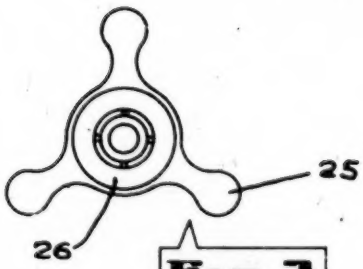

Fig. 3

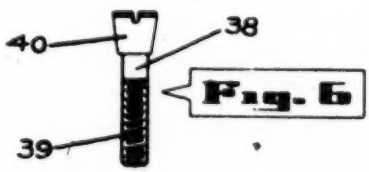

Fig. 6

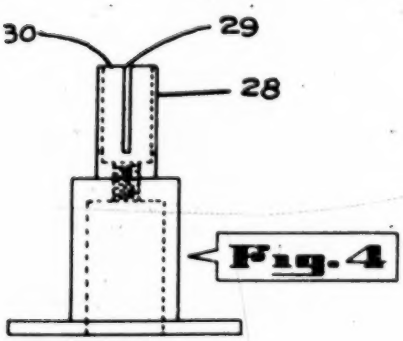

Fig. 4

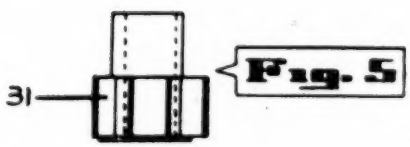

Fig. 5

Witnesses

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Joseph W. McDonnell

By

Inventors

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William A. Chryst

Kerr, Page, Cooper & Hayward

Attorneys.

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING AND WILLIAM A. CHRYST, OF DAYTON, OHIO, ASSIGNORS TO THE DAYTON ENGINEERING LABORATORIES COMPANY, A CORPORATION OF OHIO.

IGNITION SYSTEM.

1,265,454. Specification of Letters Patent. Patented May 7, 1918.

Application filed April 3, 1916. Serial No. 88,546.

To all whom it may concern:

Be it known that we, CHARLES F. KETTERING and WILLIAM A. CHRYST, citizens of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Ignition Systems, of which the following is a full, clear, and exact description.

This invention relates to an improvement in ignition systems, and more particularly to that type of ignition systems which are combined with combustion or explosion engines, and which include mechanism for properly timing and distributing the sparking impulses of the ignition system.

One of the objects of the present invention is to provide means for the adjustment of certain parts of the timing mechanism of the ignition system, whereby the position of the adjusted parts may be easily locked and maintained with precision, without danger of altering the effected adjustment of the parts during the locking operation.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of one embodiment of the present invention is clearly set forth.

In the drawings:

Figure 1 is a view in side elevation of one form of the present invention, wherein some of the elements of the timing and distributing unit are shown in section, while others are shown in elevation for the sake of clearness.

Fig. 2 is a top plan view of the unit shown in Fig. 1, with the distributer head and rotor removed to clearly illustrate the spark timing mechanism.

Figs. 3, 4, 5 and 6 are detail views of certain of the elements included in the present invention.

Referring to Fig. 1, there is disclosed what may be termed a timing and distributing mechanism, which is adapted to control the time of occurrence and the distribution of sparking impulses to an engine. This timing and distributing device is preferably driven by the engine at any predetermined ratio of speed, through a connection with the shaft 20. This shaft 20 projects into the casing 21 and is secured to a plate or disk 22, which in turn carries pins 23. These pins 23 form pivot points for the weights 24, which are mounted thereon in any suitable manner.

Each of the weights 24 engage with arms 25 of the cam carrying element 26, which in turn is mounted upon the stub shaft 27, carried by the disk 22. This cam carrying element, together with the weights 24 and certain other elements not disclosed in the drawings, form an automatic control mechanism whereby the cam carrying element is actuated relative to the engine driven shaft 20, in accordance with the varying speeds of the engine.

This automatic control mechanism above referred to, forms a part of the subject matter of the co-pending application, Serial No. 55,160, filed October 11, 1915, and no further description of these elements is deemed necessary in the present application, except where description is necessary to clearly bring out features of the present invention.

The cam carrying element 26, as has been stated heretofore, fits over the stub shaft 27, and is provided with a reduced head portion 28, which is tubular in conformation and which is suitably slotted at 29, so as to provide a plurality of expansible and slightly resilient fingers or portions 30.

This reduced head portion or shank 28 carries and supports the cam 31, which is provided with suitable lobes 32, to actuate the contact plate 33 to make and break the contact between the points 34 and 35, see Fig. 2.

The cam element 31 is provided with a reduced head portion or shank 36, which is provided with a flat on each side, as at 41, to prevent relative movement of the distributer rotor 37, which is carried by the cam element directly.

It is well known to those skilled in the art that it frequently becomes advisable to change the adjustment of the cam and rotor, relative to the contact plate 33 and the stationary contacts 34 and 35 of the distributer.

It is also well understood that this adjustment of the cam element and the rotor must be maintained with precision, so as to secure the efficient operation of the timing and distributing mechanism.

In the form of the invention shown in the present instance, the locking element 38 comprises a bolt or screw, having a threaded

portion 39 and a wedge-shaped head or expanding portion 40. This locking element is inserted within the tubular portion 28 of the cam carrying element 26, and may be screwed into the threaded bore formed in the portion 28 of the cam carrying element 26, see Figs. 1 and 4.

As this locking element is being screwed home, the wedge shaped head tends to cause the resilient fingers to expand and to frictionally engage the cam carrying element 26, and to securely lock the same in its adjusted position.

It will therefore be seen that not only the cam element 26, but also the rotor of the distributer will be locked or held in a fixed adjusted position by means of this locking element 38, inasmuch as the rotor of the distributer is carried directly by the cam element 26.

When it is desired to effect further adjustment of the cam and distributer rotor, it is simply necessary to unscrew the locking bolt 38, and manually set the cam to the desired position and then screw the locking element back into locking position.

By referring to Fig. 1, it will be noted that the locking element does not directly engage with any element which is capable of permanent adjustment relative to the engine driven shaft. Therefore, there is no tendency to actuate either the cam directly or indirectly during the locking operation, that is, during the time that the locking element is being screwed home. Therefore, there is no tendency to throw the cam out of its set position.

While the form of mechanism herein shown and described constitutes a preferred form of embodiment of the invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What we claim is as follows:

1. In a device of the character described, the combination with a driving shaft; of an ignition system, including a cam carrying element connected to said driving shaft, said element having a slotted shank portion; a cam adapted to fit over said shank portion; and means for expanding said slotted shank into contact with the cam to maintain said cam in adjusted position.

2. In a device of the character described, the combination with a driving shaft; of an ignition system, including a cam carrying element connected to said driving shaft, said element having a slotted shank portion; a cam adapted to fit over said shank portion; a distributer rotor carried by said cam; and means for expanding the slotted shank into contact with said cam to adjustably maintain the cam and rotor in adjusted position.

3. In a device of the character described, the combination with a driving shaft; of an ignition system, including a cam carrying element connected to the driving shaft; said element having an expansible shank portion; a cam adapted to fit over said shank portion; and means operable relative to the expansible portion for locking said cam in adjusted position.

4. In a device of the character described, the combination with a driving shaft; of an ignition system, including a cam carrying element connected to the driving shaft; said element having an expansible shank portion; a cam adapted to fit over said shank portion; and a locking element having a wedge-shaped head adapted to be forced into said shank portion to expand the same and thereby lock the cam in adjusted position.

In testimony whereof we affix our signatures in the presence of two subscribing witnesses.

CHARLES F. KETTERING.
WILLIAM A. CHRYST.

Witnesses:
J. W. McDONALD,
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P. FELIX.

MULTICYLINDER ENGINE.

APPLICATION FILED DEC. 8, 1916.

1,276,891.

Patented Aug. 27, 1918.

3 SHEETS—SHEET 1.

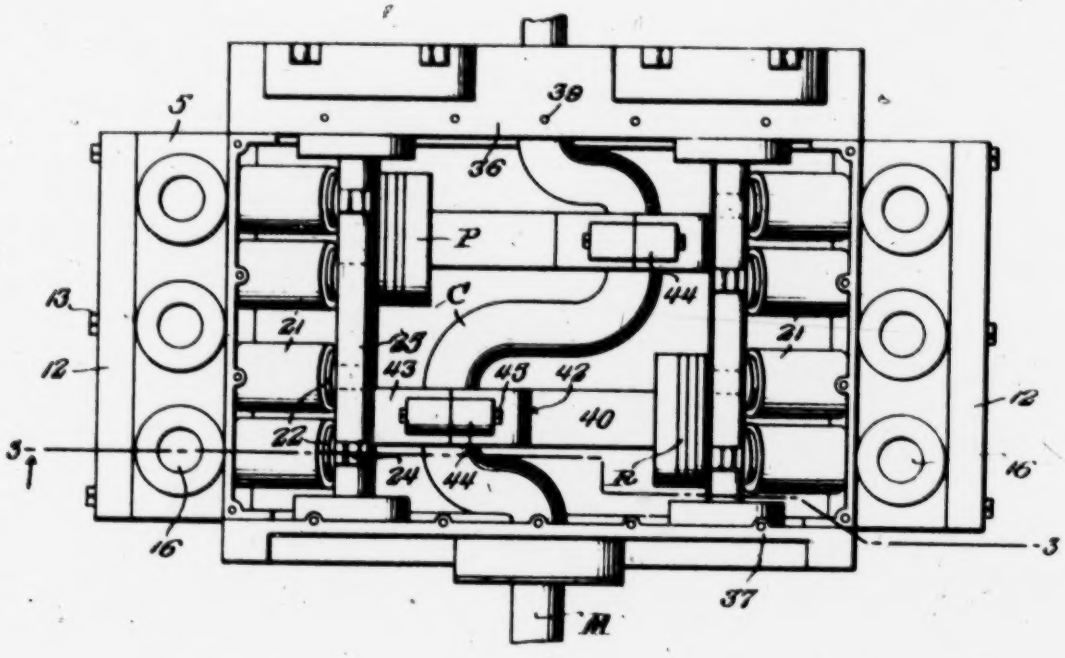

Fig. 1.

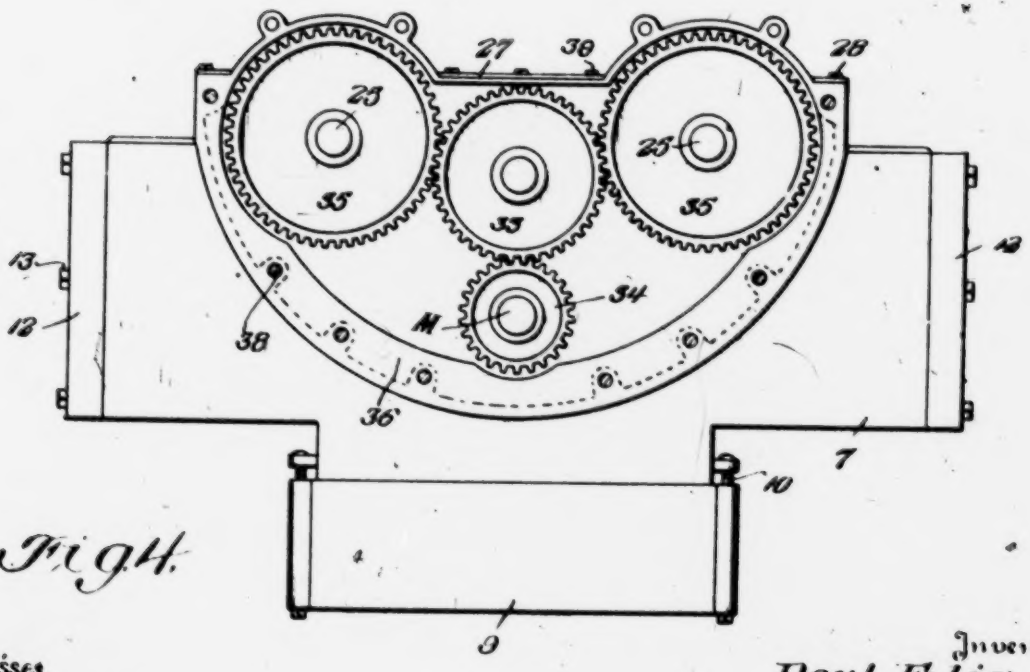

Fig. 4.

Witnesses

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MULTICYLINDER ENGINE.

APPLICATION FILED DEC. 8, 1916.

1,276,891.

Patented Aug. 27, 1918.

3 SHEETS SHEET 2.

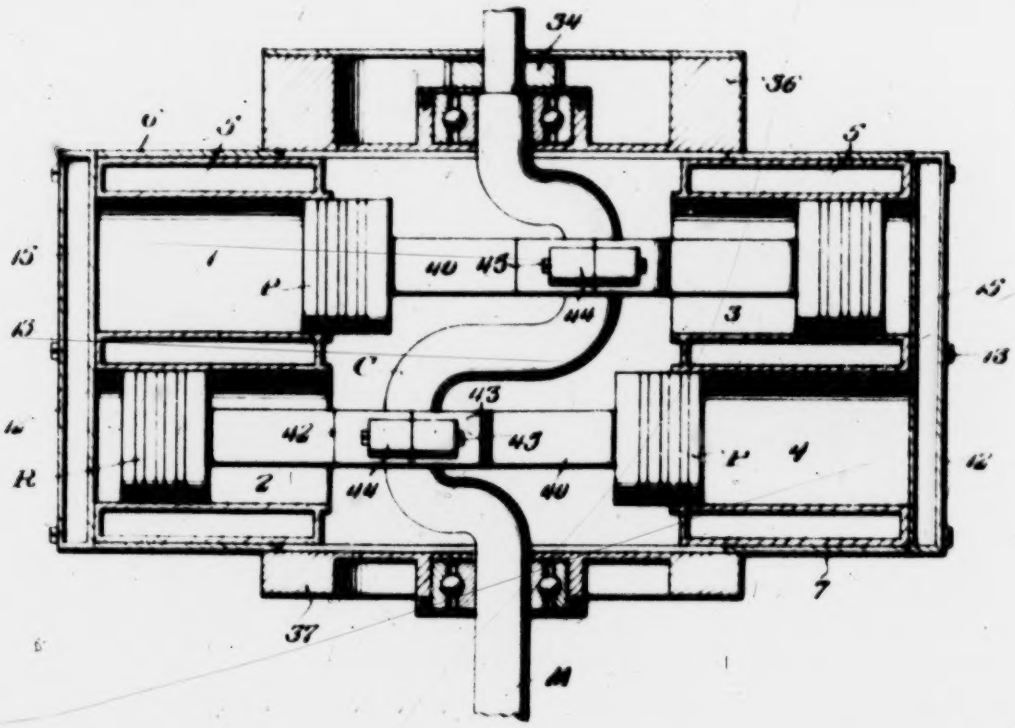

Fig. 2.

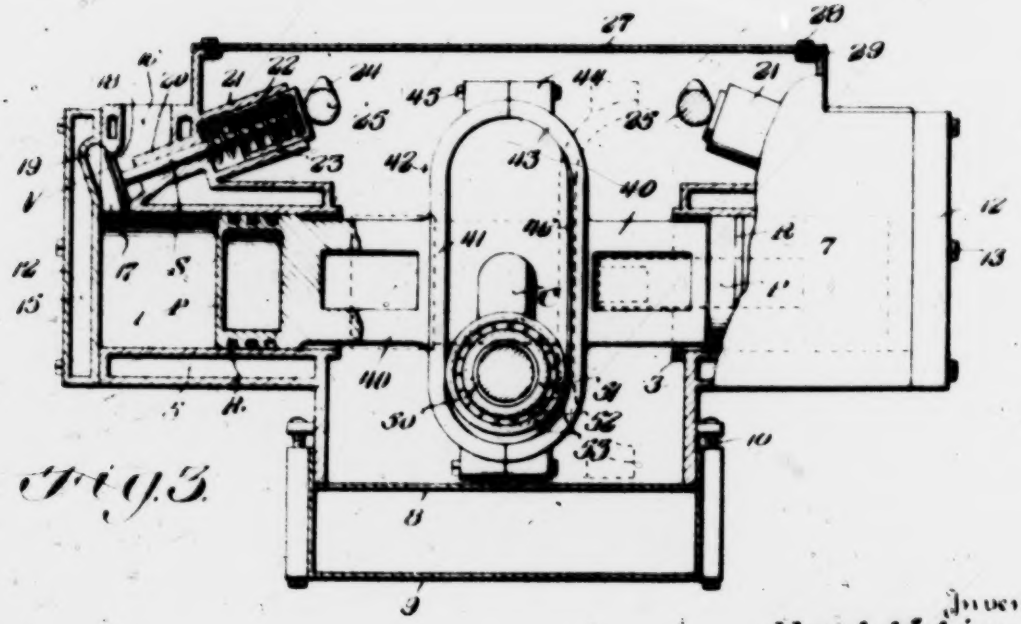

Fig. 3.

Witnesses

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Attorney

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MULTICYLINDER ENGINE.

APPLICATION FILED DEC. 8, 1916.

1,276,891.

Patented Aug. 27, 1918.

3 SHEETS—SHEET 3.

Fig. 6.

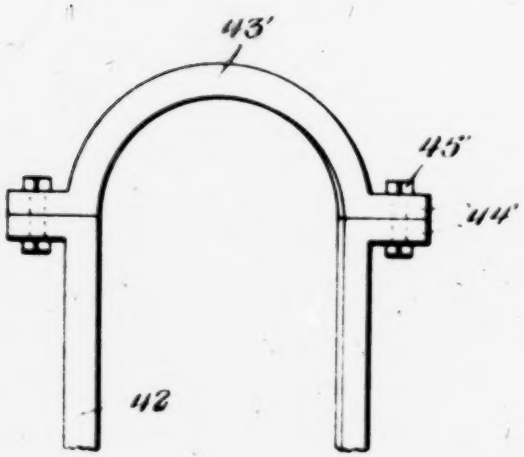
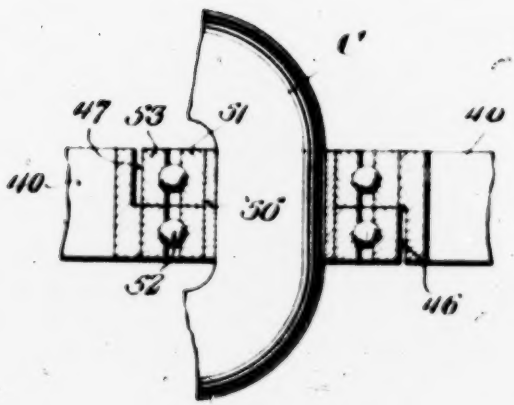


Fig. 4.



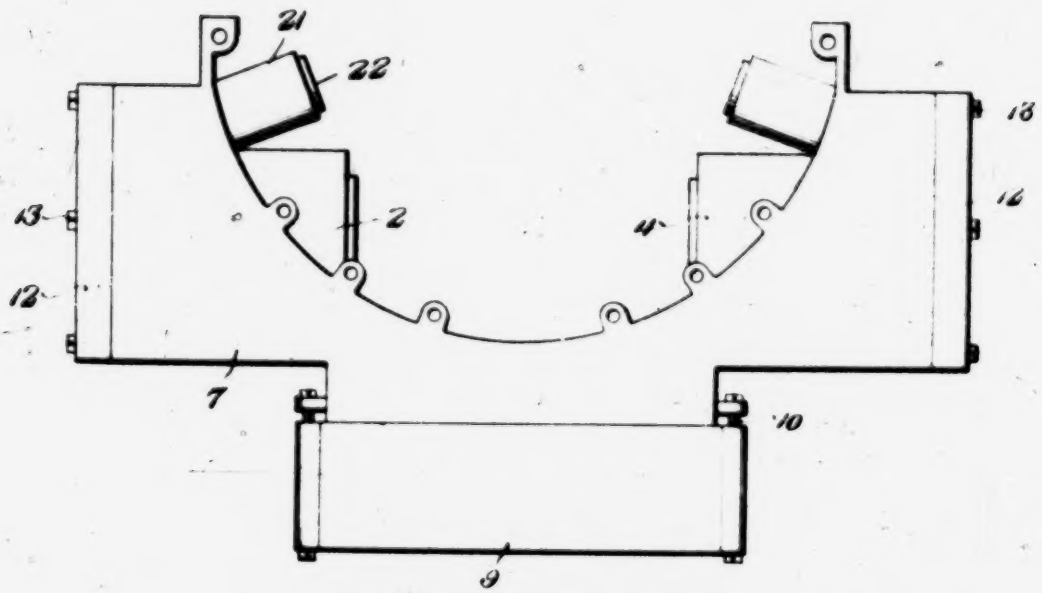


Fig. 5.

Inventor

Paul Felix,

Witnesses

J. H. Crawford

N. L. Cleaver

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UNITED STATES PATENT OFFICE.

PAUL FELIX, OF KNOXVILLE, TENNESSEE.

MULTICYLINDER ENGINE.

1,276,891. Specification of Letters Patent. Patented Aug. 27, 1918.

Application filed December 8, 1916. Serial No. 135,843.

To all whom it may concern:

Be it known that I, PAUL FELIX, a citizen of the United States, residing at Knoxville, in the county of Knox and State of Tennessee, have invented new and useful Improvements in Multicylinder Engines, of which the following is a specification.

This invention relates to internal combustion engines, and more especially to those having opposed cylinders; and the objects of the same are to eliminate the conventional connecting rods, to permit of the casting of the cylinders *en bloc* with the crank case, to provide a special structure whereby the two cam shafts and the crank shaft may be bodily removed, to protect the shafts and the valves and pistons within a single housing and lubricate them automatically, to provide a special mounting for the roller bearings between the pistons and the cranks, and generally to simplify construction, reduce friction and increase power. These and other objects will be accomplished by the construction hereinafter more fully described and claimed, and as shown in the drawings wherein—

Figure 1 is a plan view of this engine with the cover removed.

Fig. 2 is a horizontal section.

Fig. 3 is a vertical section with the cover in place, being taken on about the line 3—3 of Fig. 1.

Fig. 4 is an end view of the entire structure, Fig. 5 an end view of the main casting, Fig. 6 an enlarged detail of a slight amplification, and Fig. 7 a horizontal section through the bearing for one of the cranks.

In the accompanying drawings is shown my invention as applied to a four-cylinder engine, although of course it will be understood that I am not limited in this respect. Also the cylinders are shown as water-jacketed, each with an inlet and an outlet valve whose details of construction are not important, and I have purposely omitted other features not involved in this invention, as, for instance, the ignition system, the timing system, the carbureter, etc. One casting in the present instance is made to include the four cylinders 1, 2, 3, 4 and their water jackets 5; and the cut out end plates 6 and 7 are attached to the crank casing. The bottom of the latter may be closed by an integral plate or by a separate bottom plate as shown at 8 in Fig. 3, and there may be a subjacent pan 9 adjustably supported as by screws 10 engaging lugs. The outer ends of the cylinders are closed by heads 12 preferably having their own jackets 15, and these heads are held removably in place by screws 13. The casting also contains valve chambers 16, each communicating by means of a port 17 with its own cylinder and having its own seat 18 which is preferably inclined as explained below, the inner jacket wall of the head plate 12 being indented as at 19 to give free movement to the valve heads V. The casting is also formed with a tubular guide or boss 20 standing at about twenty degrees above a horizontal and through which passes the valve stem S. The casting also carries, or it may be formed integral with, a spring chamber 21 which stands coaxial with the boss 20 and into which the stem S projects. Said stem at its inner end is provided with any suitable form of head or cap 22, and a coiled expansive spring 23 surrounds the stem between this cap and the lower end of the chamber for holding the head of the valve V normally against its seat 18 as usual. The cam 24 on the cam shaft 25 bears against the cap 22—all as best seen in Fig. 3, but I do not consider it necessary to illustrate or describe the inlet manifold or the exhaust manifold. The charge is supplied to the inlet valve and the burnt gases taken from the outlet valve in any suitable manner forming no part of the present invention. Within each cylinder reciprocates a piston P having the usual rings R. The cylinders in the present case are arranged in pairs, opposed to each other, numbers 1 and 3 being opposite and alined with each other and numbers 2 and 4 opposite and alined. Between them stands the main shaft M which in the present case is shown as provided with two cranks C. The open top of the crank casing (which latter is shaped to include the parts already described) is closed by a cover plate 27 held removably in place by screws 28 engaging holes 29 in the shell of said casting, or in any other appropriate manner.

One important feature of my invention is the removability of the main shaft and the two cam shafts, without disturbing other elements, and this is accomplished as follows: There are two removable end plates 36 and 37 bolted at 38 respectively to and complementing the end plates 6 and 7, and

at 39 to the ends of the cover plate, and each removable end plate has bearings for the three shafts mentioned; the cam shafts having gears 35 beyond one end plate, the main shaft having a half sized gear 34, and an idle gear 33 connecting them as best seen in Fig. 4. Thus it will be seen that, when the cover plate is removed and the end plates 36 and 37 detached from the main casting, said plates and shafts may be lifted entirely out of the main casting in a manner which will be made clear below, and then, by first removing the gears, the plates and their bearings can be slipped off from the extremities of the shafts. Also by a reversal of the operation, the parts can be quickly restored to their original position after repairs have been made.

Another important feature of my invention is the specific means employed for communicating the reciprocating motion of opposed pistons to the cranks of the main shaft, resulting in rotary motion of the latter, while doing away with the usual connecting rods and this is accomplished as follows: The stems 40 of each pair of pistons are carried inward and respectively connected (preferably integrally) with the heads of sides 41 or an upright yoke 42 of loop or oval shape which stands midway between the two piston heads P. The upper and lower ends of the sides 41 are by preference arched toward each other as at 43 and provided with external lugs 44 detachably connected by means of bolts 45; and one-half of the inner face of one side is cut away or recessed as seen at 46 on Fig. 7, while the other half of the opposite side is cut away or recessed as at 47, for a purpose yet to be described.

Around the crank C is preferably shrunk a sleeve or collar 50, around this in turn and standing side by side are closely fitted channeled rings constituting the inner races or members 51 of two roller or ball bearings, next outside these members are the balls 52, and next outside the balls are the channeled rings constituting other races or members 53; and by reason of the cutaway portions or recesses 46 and 47, these outer members have each a certain clearance within one side of the yoke 42. That is to say, the left side 41 of the yoke on the piston within cylinder 1 forms a track which contacts closely with the outer member 53 of its roller bearing, whereas the right side has a clearance as at 47, and the reverse is true of the piston within the opposite cylinder. The result is that, during the operation of the engine, the turning of the main shaft M causes the rotation of the crank C; the latter carries with it the sleeve or collar 50 and the inner member 51 of the bearing, the balls or rollers 52 therein move at half speed, and the outer member 53 rises and falls within the yoke, but it serves as a wheel and rolls as it travels up and down in contact with the track at the left side 41 thereof whereas the right side of the yoke by reason of the clearance 47 is out of contact with the right side of such wheel 53 to permit its rolling. It is to be understood that the parts are all lubricated by a splash system, because the casing contains a volume of oil which is kept in constant agitation by the reciprocating movements of the pistons and the yokes and the rotary movement of the cranks, with the result that the pistons are well oiled where they reciprocate within their cylinders, the cranks and the bearings where they move within their yokes, the valve stems and caps where they move within their guides and chambers, and the cams where they contact with said caps,—therefore no additional system of lubrication is necessary.

In Fig. 6 I have illustrated a slight amplification, which consists in closing the upper end of each yoke 42 by a semi-circular arched member 43′, connecting the latter by lugs 44′ and bolts 45′ with the upper ends of the straight upright sides 41, instead of across the top of the arch as best seen in Fig. 3. When these arches 43′ are removed it is obvious that the crank shaft may be lifted out of the yokes without disconnecting the sides of the latter at the bottom. This amplified construction may be used although it involves an additional bolt and additional parts, but I do not wish to be limited in this respect.

The operation of engines of this kind is too well understood to need a detailed description here. The construction which I have illustrated and described will produce the advantages herein set forth in this specification, and I do not wish to be limited to details beyond those recited in the following claims.

An important feature of the present invention is the accessibility of the moving parts of this engine from within the casing when the shafts are removed as above suggested, and from the sides of the casing at all times by withdrawing or removing the heads 12. The latter operation of course exposes the outer ends of the cylinders, the piston and valve heads, and the valve seats; and the inner ends of the cylinders as well as the caps at the inner ends of the valve stems are exposed from the interior of the casing. By removing said caps the valves can be drawn out for grinding, repair, or substitution. When it is necessary to remove a piston, the two sides of the yoke are disconneted as above described, two opposed pistons turned until the respective sides of their yokes stand at right angles to each other as dotted in Fig. 3, and one piston moved outward to the extreme within its cylinder when the other

piston may be moved inward until its head comes out of its own cylinder, and then lifted out of the casing.

If it be desired to remove the crank shaft without taking the pistons out of the casing, the arches 43' at the upper end of the yoke are detached by removing the bolts 45' which are easily accessible when the top plate is withdrawn, and the crank shaft and both the cam shafts may be lifted out in a manner already described and without disarranging the connection of any pair of opposed pistons. The wheels 53 and their roller bearings come out with the main shaft at this time, because the removal of the arches uncovers the upper end of the track on which these wheels travel.

What is claimed as new is:

In an internal combustion engine, the combination with opposed cylinders, pistons therein, a main shaft whose cranks stand between relatively opposite pistons, and a sleeve fast on its crank; of an upright loop-shaped yoke connecting the stem of each pair of pistons and made of an arched top, upright sides whose inner faces are cut away at their respectively opposite edges to leave tracks along their remaining edges, and means for connecting the lower end of their sides and the extremities of the top to the upper end of the track, and on each sleeve two bearings including channeled ring-shaped inner members disposed side by side on the sleeves, balls in their respective channels, and channeled outer members surrounding said balls and constituting wheels, each traveling on one of said tracks within the yoke as the latter reciprocates during the rotation of the crank.

In testimony whereof I affix my signature.

PAUL FELIX.

W. H. PITTS.

AUTOMATIC COMMUTATOR.

APPLICATION FILED JULY 9, 1917.

1,281,204.

Patented Oct. 8, 1918.

3 SHEETS—SHEET 1.

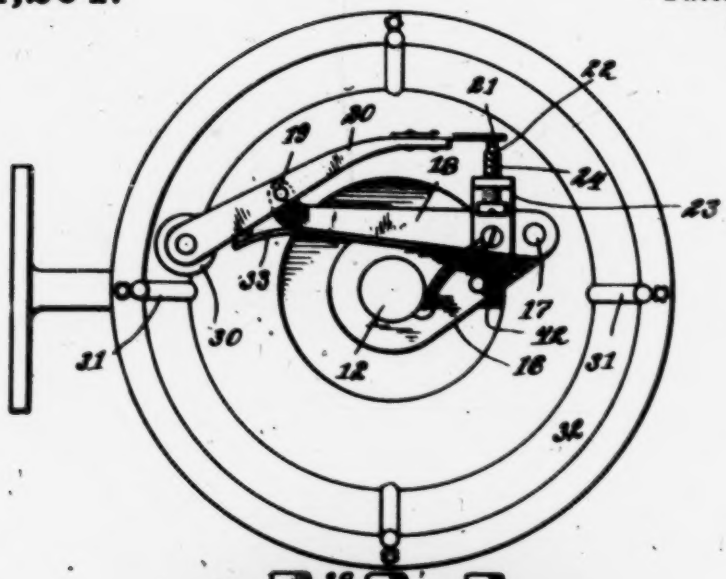

Fig. 1

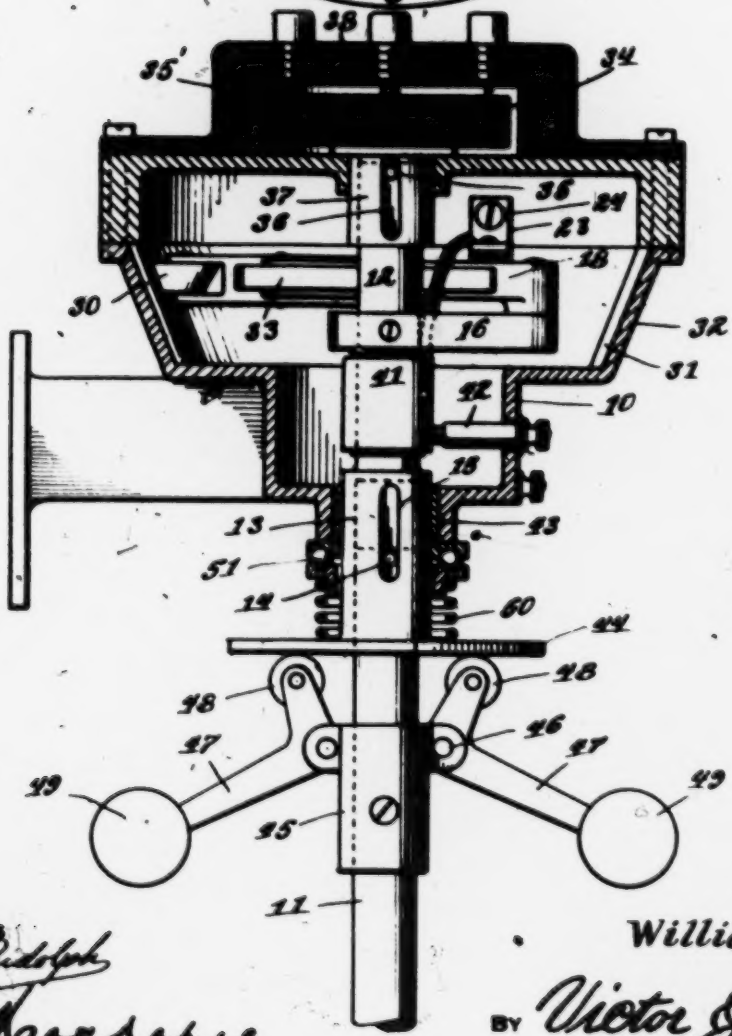

Fig. 2

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APPLICATION FILED JULY 9, 1917.

1,281,204.

Patented Oct. 8, 1918.

3 SHEETS—SHEET 2.

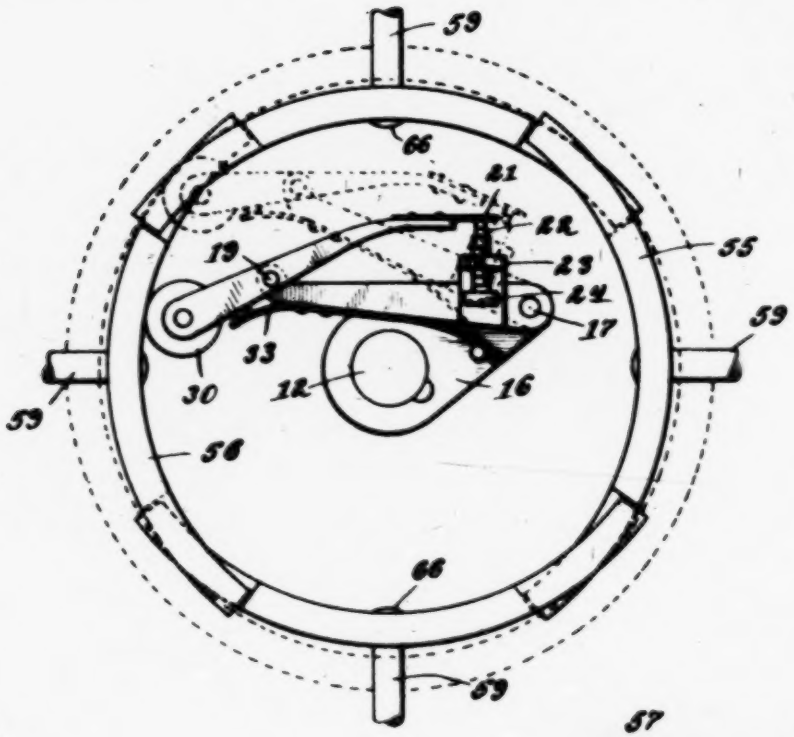

Fig. 6

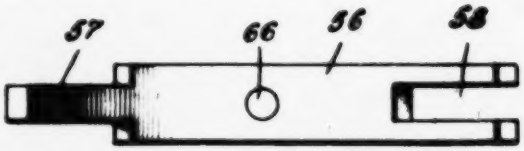

Fig. 7

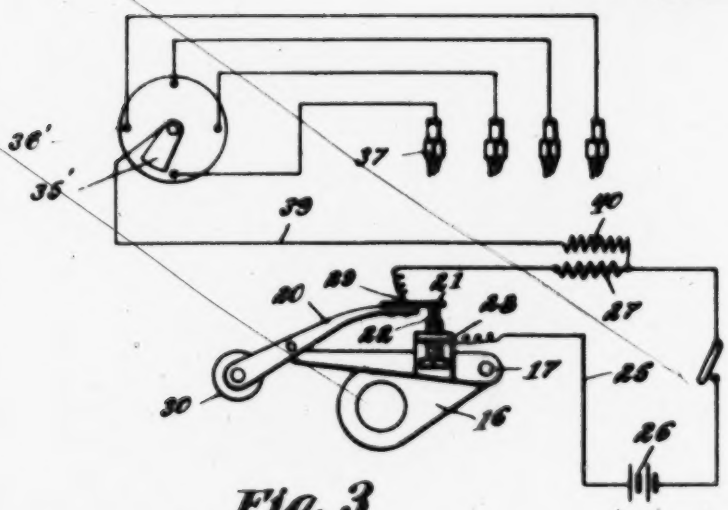

Fig. 3

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3 SHEETS—SHEET 3.

Fig. 4

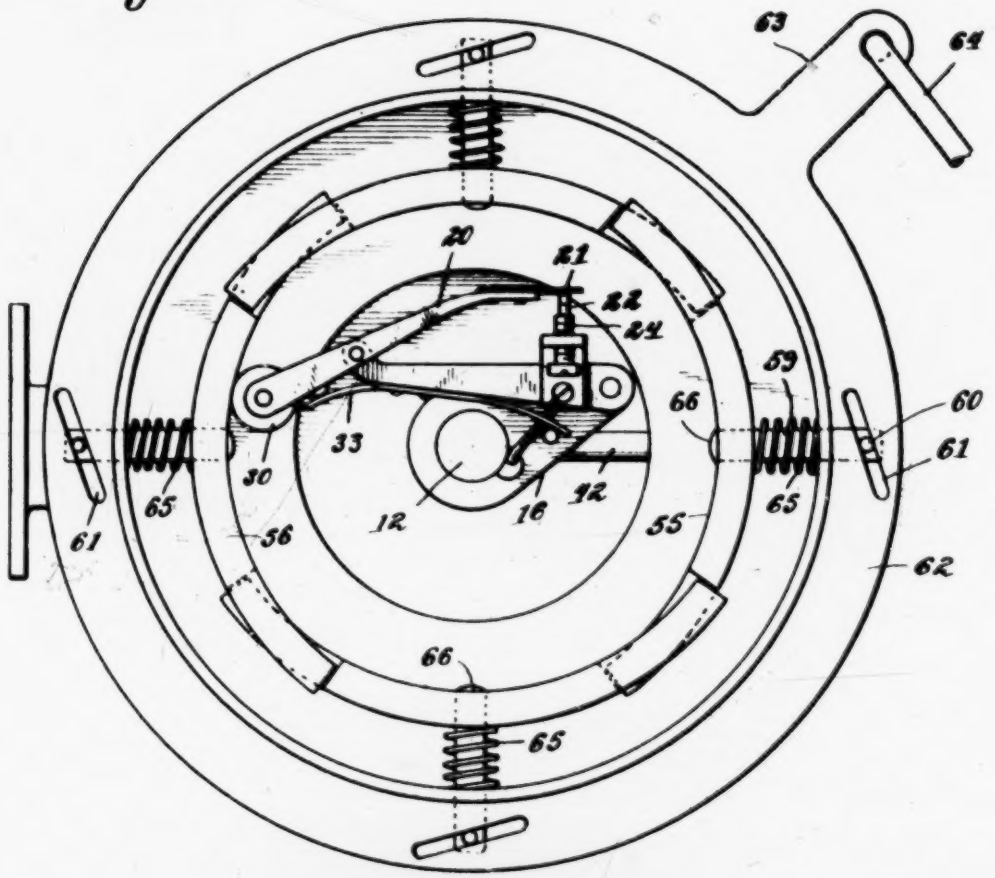
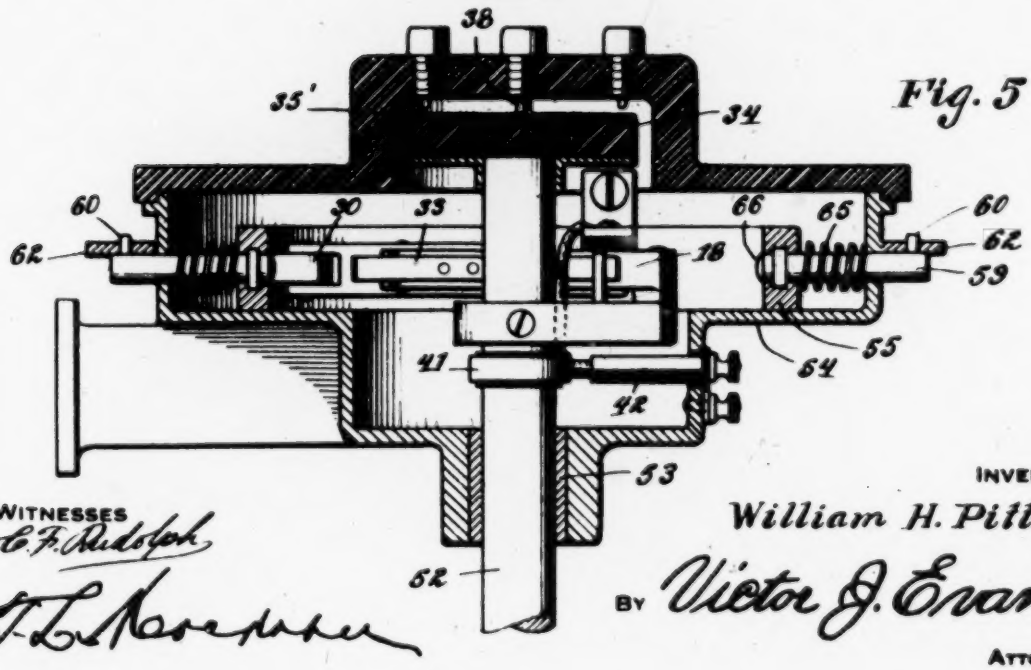


Fig. 5



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UNITED STATES PATENT OFFICE.

WILLIAM H. PITTS, OF WALLA WALLA, WASHINGTON.

AUTOMATIC COMMUTATOR.

1,281,204. Specification of Letters Patent. Patented Oct. 8, 1918.

Application filed July 9, 1917. Serial No. 179,506.

To all whom it may concern:

Be it known that I, WILLIAM H. PITTS, a citizen of the United States, residing at Walla Walla, in the county of Walla Walla and State of Washington, have invented new and useful Improvements in Automatic Commutators, of which the following is a specification.

This invention relates to commutators for use in connection with internal combustion engines and aims to provide means whereby the ignition spark may be advanced or retarded to control the speed of the engine.

An object of the invention is to provide means whereby the interrupter arm may be either automatically or manually moved with respect to its operating shaft and consequently with respect to the position of the engine piston, so as to cause a change in the time of the explosion of the charge within the cylinder.

A further object of the invention is to provide a novel form of interrupter arm including novel means of mounting the same, the said arm being normally adapted to travel within a given radius, which may be increased or decreased to cause a change of position of the said arm with respect to the shaft, for the purposes above set forth.

With the above and other objects in view, the invention consists of the following novel combination and arrangement of parts, hereinafter more fully described and illustrated in the accompanying drawings, in which—

Figure 1 is a top plan view of a commutator constructed in accordance with the present invention, the cover and distributer disk being removed;

Fig. 2 is a central sectional view through the commutator complete;

Fig. 3 is a diagrammatic view illustrating the wiring of the commutator and its connection with the spark plugs of an engine;

Fig. 4 is a plan view of a modified form of the invention, with the cover and distributer disk removed;

Fig. 5 is a central sectional view of the commutator showing Fig. 4 complete;

Fig. 6 is a detail plan view showing the normal position of the parts in full lines and showing by dotted lines the position of the parts when the spark is advanced; and

Fig. 7 is a detail perspective view of one of the sections of the expansible ring shown in Fig. 6.

Referring to the drawings in detail, 10 includes a casing, in which is mounted a shaft 11 driven from any suitable source of power, for example, through a suitable gearing connected to the cam shaft of the engine, so that the said shaft 11 will be timed to rotate with the operation of the engine piston.

The shaft 11 is formed in two sections, the upper section 12 of which is connected with the lower section through the medium of a sleeved end 13, the adjacent end of the lower section fitting within this sleeve and carrying a pin 14, which operates within a slot 15 provided in the sleeve, in order that the upper section may be moved longitudinally with respect to the lower section 12.

The upper section 12 of the shaft has secured thereto an arm 16, which is adapted for rotation with said shaft, the said arm having pivoted upon its outer end as indicated at 17 one end of a lever 18. The opposite end of this lever has pivoted thereto as shown at 19 an interrupter arm 20, the said arm being pivoted intermediate its ends, and one end of which is provided with a contact point 21, which is adapted for engagement with the contact point 22, which is adjustably mounted upon the lever 18 by means of a bracket 23 and an adjusting screw 24. The contact points 21 and 22 are included in the primary electric circuit 25, which receives current from a suitable source 26. Also included in this circuit is a primary coil 27, one terminal of the circuit being connected to one switch point as shown at 28, while the other terminal is connected to the opposite switch point as shown at 29.

The arm 20 preferably carries at its outer end a roller 30, which when the shaft 11 is rotated, is adapted to contact with a series of spaced interrupter points 31, supported by an inclined wall 32 of the casing 10, the roller 30 being held in engagement with the wall 32 through the medium of the spring 33.

The upper end of the section 12 of the shaft 11 is connected to a distributer disk 34 through the medium of a pin 35, which is keyed to the slot 36 provided in the sleeve 37 secured to the under side of the disk 34. This disk is rotatable with the shaft 11 and carries a contact plate 35′, which is adapted to successively engage the series of contact points 36′, which are electrically connected to the spark plugs 37 of the engine cylinders.

The contact plate 35' is engaged with the brush 38, which is connected to the secondary circuit through the medium of a conductor 39 in the secondary coil 40.

Mounted upon the section 12 of the shaft 11 is a collector ring 41, which the brush 42 engages in the usual manner.

From the foregoing it is apparent that the rotation of the shaft 11 will cause the roller mounted upon the end of the arm 20 to successively engage the interrupter points 31 to break the circuit 25 through the contacts 21 and 22 to make the spark.

In order to advance the spark it is necessary to change the position of the end of the arm 20 which contacts with the interrupter points, with respect to the shaft 11 and to accomplish this, the said shaft is mounted for vertical movement within a bearing 43 in the casing 10, the sleeve 13 upon which connection is made between the two sections of the shaft being provided with an annular flange 44. Mounted upon the shaft 11 beneath the flange is a sleeve 45, provided with ears 46, between which are provided bell crank levers 47, one end of each of said levers being provided with a roller 48, which engages the under face of the flange 44, while the opposite ends of each of the bell cranks is provided with a weight 49, the whole providing a centrifugal governor which is operated by the rotation of the shaft to move the section 12 thereof vertically as will be understood by reference to Fig. 2 of the drawings. Interposed between the disk 44 and the casing 10 is a coil spring 50, one end of which bears against the upper face of the flange and the opposite end bearing against a thrust bearing 51, so as to provide for a free rotation of the flange and at the same time exert a downward pressure upon the centrifugal governor.

With the increased speed of the shaft 11, the governor will cause the upper section 12 of the shaft to rise, carrying with it the interrupter arm 20 and as the spring 42 acts to force outwardly the end of the arm carrying the roller 30, the angular position of this roller will be changed with respect to the shaft 11, moving the roller around said shaft in an arc tangent thereto, so that the spark will occur in advance of its normal time. The reduction of the speed of the shaft 11 will cause the lowering of the section 12 and a movement of the roller 30 around the said shaft in the opposite direction, causing the consequent retarding of the spark.

In the form of the invention shown in Figs. 4 to 7 inclusive, the shaft 52 is not movable longitudinally, it being mounted for rotation upon the bearing 53 provided with a casing 54.

This casing has located therein an expansible ring 55 composed of a plurality of arcuate sections 56, each of which is formed at one end with a tongue 57, and its opposite end with a slot 58, the tongue 57 of one section entering the slot 58 of the adjacent section and capable of sliding movement therein.

Each of the sections 56 is provided with a radially arranged rod 59, one end of which is secured to the section 56, the opposite end of the said rod being provided with a pin 60, which is adapted to engage the cam slot 61 provided in the ring 62, which surrounds the casing 54 and is capable of rotation thereon. The ring 62 is provided with an arm 63, which is connected to any suitable automatic or manually operating means through the medium of a rod 64. A movement of the ring 62 around the casing 54, will through the medium of the slots 61 cause the section 56 of the ring 55 to move inward or outward, to increase or decrease the diameter of the ring, to change the position of the roller 30 with respect to the shaft 52 as set forth in the description of the previous form of the invention, the roller 30 being carried by the arm 20, which is secured to the shaft 51 as in the previously explained form.

The sections 56 of the ring 55 are normally pressed inward to decrease the diameter of the ring, through the action of springs 65, which are mounted on the rods 50, the inner ends of these rods extending through to the inside of the ring and forming interrupter points 66, for contact with the roller 30 so as to break the circuit and cause the spark. In other respects, the construction and operation of the invention is similar to the form previously described and it is not thought necessary to repeat the same.

Various changes in the form, proportion and minor details of construction may be made and the right is reserved to make such changes as will fall within the scope of the claims hereto appended.

Having described the invention, what is claimed is:

1. A commutator embodying a longitudinally movable rotatable shaft, an electric circuit, an element associated with said shaft for rotation therewith and controlling said circuit, said arm being capable of lateral movement with respect to the shaft,—interrupter points located in the path of movement of said element for creating a spark and means including a wall of varying diameter for permitting a longitudinal and lateral movement of said element for advancing or retarding the spark.

2. A commutator embodying a longitudinally movable rotatable shaft, an electric circuit, an element associated with the shaft for rotation therewith, said element controlling said circuit, interrupter points located in the path of movement of said element for creating a spark and means including an in-

clined wall for permitting the shifting of said element through the longitudinal movement of the shaft for advancing or retarding the spark.

3. A commutator embodying a longitudinally movable rotatable shaft, an arm secured thereto, a spring controlled lever having one end pivotally secured to said arm, a spring pressed element pivotally secured to the opposite end of said lever, an electric circuit, interrupter points located in the path of movement of said element for interrupting the circuit for creating a spark and means whereby the arm may be moved laterally with respect to the shaft upon longitudinal movement of the latter for advancing or retarding the spark.

4. A commutator embodying a vertically movable rotatable shaft, an arm secured thereto, a lever having one end pivotally secured to said arm, a pivoted element carried by said lever, a single spring secured to the lever for urging the latter and the pivoted element away from said shaft, an electric circuit, interrupter points located in the path of movement of said element for interrupting the circuit to create a spark and means whereby the arms may be moved laterally with respect to the shaft upon longitudinal movement of the latter for advancing or retarding the spark.

5. In a commutator, a rotatable shaft, an electric circuit, spaced interrupter points, an arm rigidly secured to said shaft and rotatable thereof, an arm having one end pivotally secured to the first mentioned arm, a lever pivotally secured to the opposite end of the second mentioned arm and adapted to engage the spaced interrupter points, a circuit breaker included in said circuit and interposed between the first and second mentioned arms and spring actuated means for normally closing the circuit breaker and holding the second mentioned arm in position for engagement with the interrupter points.

6. In a commutator, a rotatable shaft, an electric circuit, spaced interrupter points, an arm rigidly secured to said shaft and rotatable therewith, an arm having one end pivotally secured to the first mentioned arm, a lever pivotally secured to the opposite end of the second mentioned arm and adapted to engage the spaced interrupter points, a circuit breaker included in said circuit and interposed between the first and second mentioned arms and a common spring actuated means for normally closing the circuit breaker and holding the second mentioned arm in position for engagement with the interrupter points.

In testimony whereof I affix my signature.

WILLIAM H. PITTS.

R. S. SMITH.

MAGNETO GENERATOR.

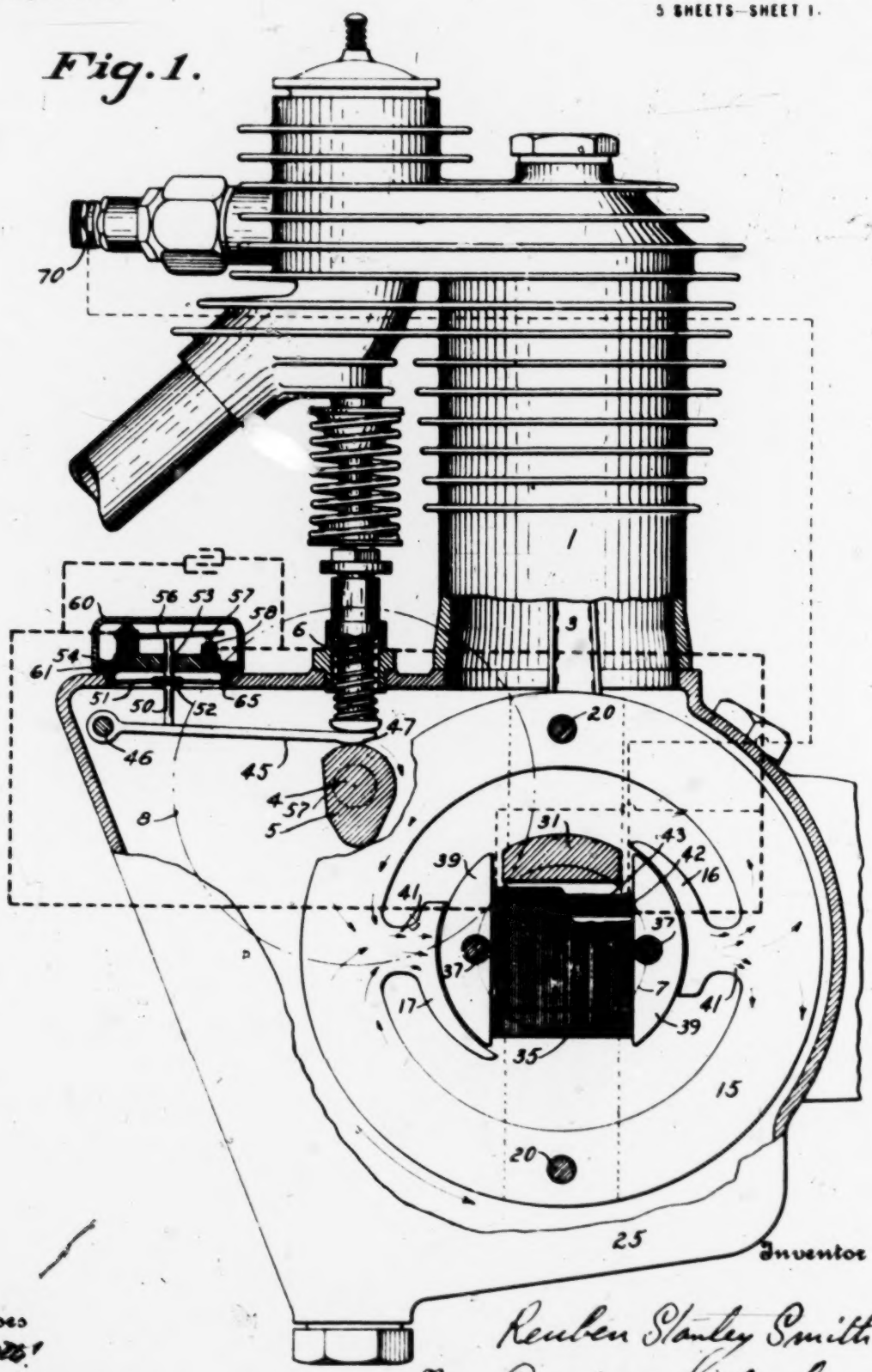
APPLICATION FILED SEPT. 2, 1916.

1,291,216.

Patented Jan. 14, 1919.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses

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MAGNETO GENERATOR.

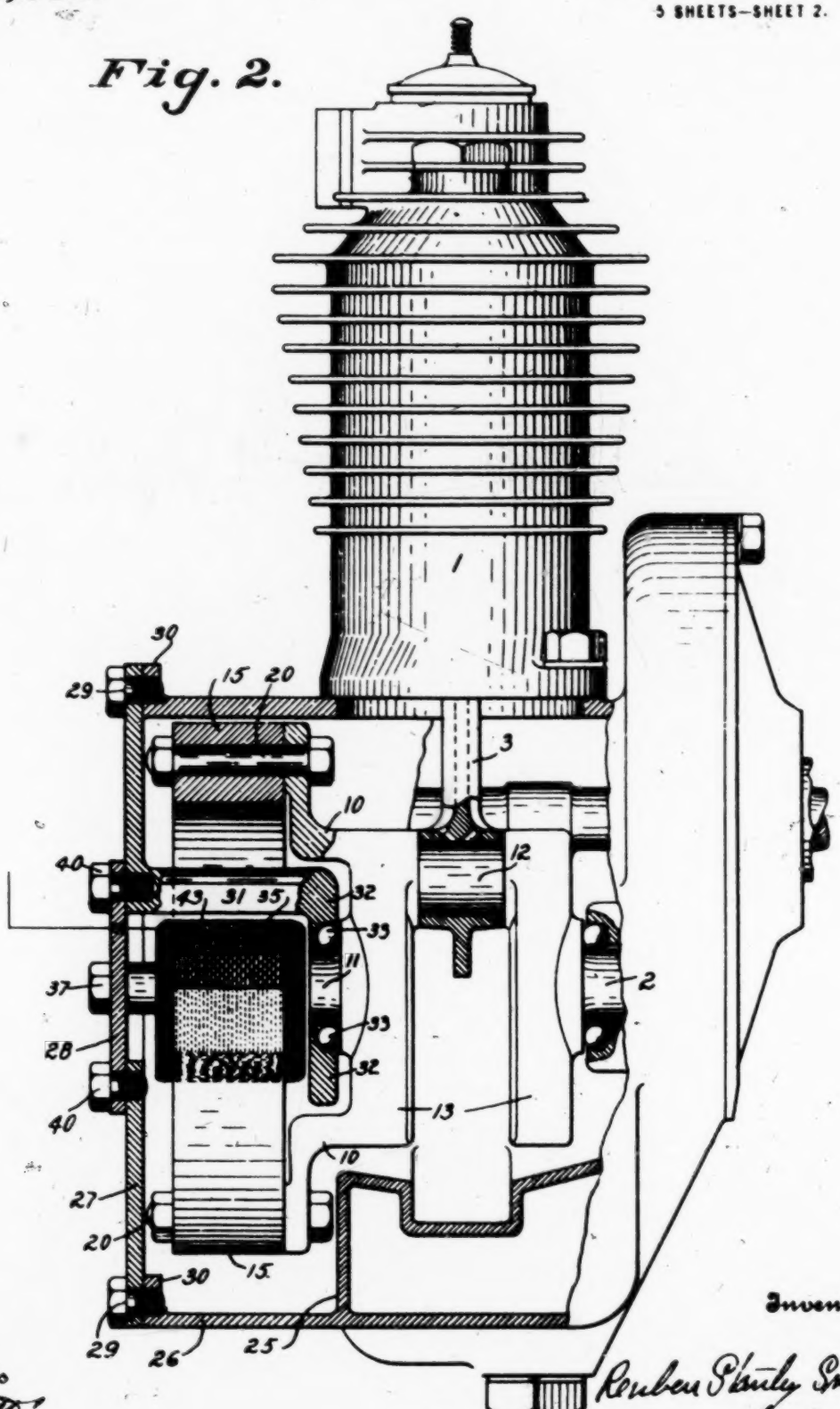
APPLICATION FILED SEPT. 2, 1916.

1,291,216.

Patented Jan. 14, 1919.

5 SHEETS—SHEET 2.

Fig. 2.



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APPLICATION FILED SEPT. 2, 1916.

1,291,216.

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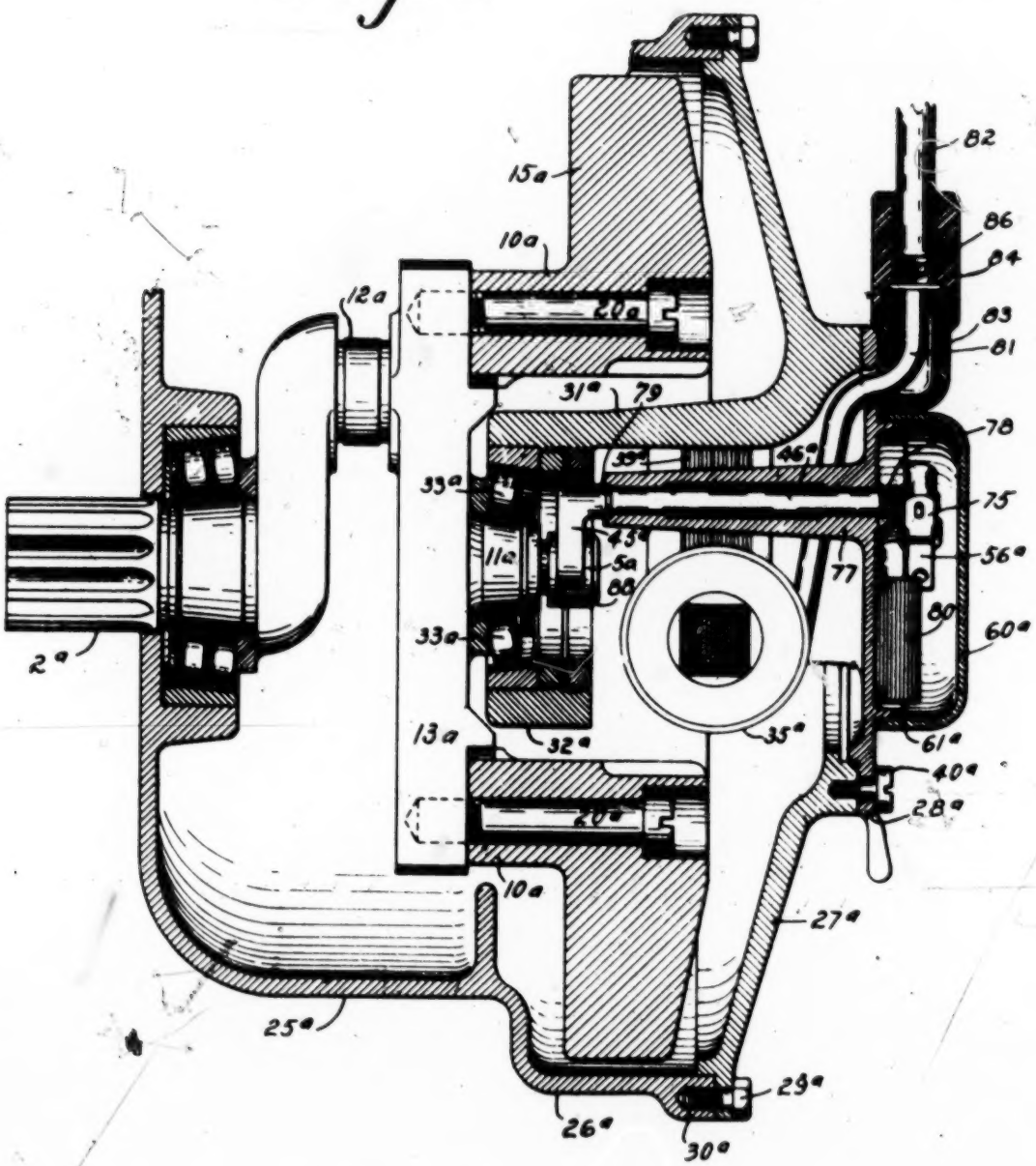
3 SHEETS—SHEET 3.

Fig. 3.



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APPLICATION FILED SEPT. 2, 1916.

1,291,216.

Patented Jan. 14, 1919.

5 SHEETS—SHEET 4.

Fig. 5.

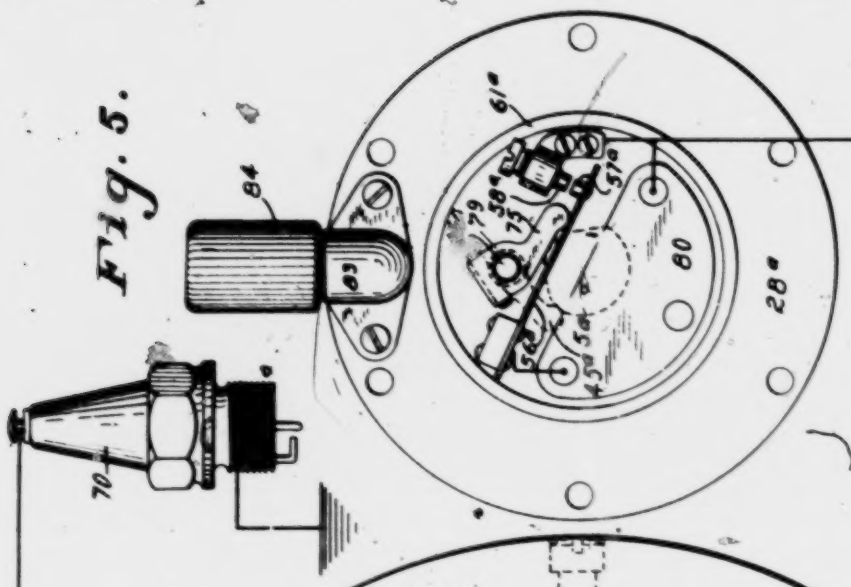
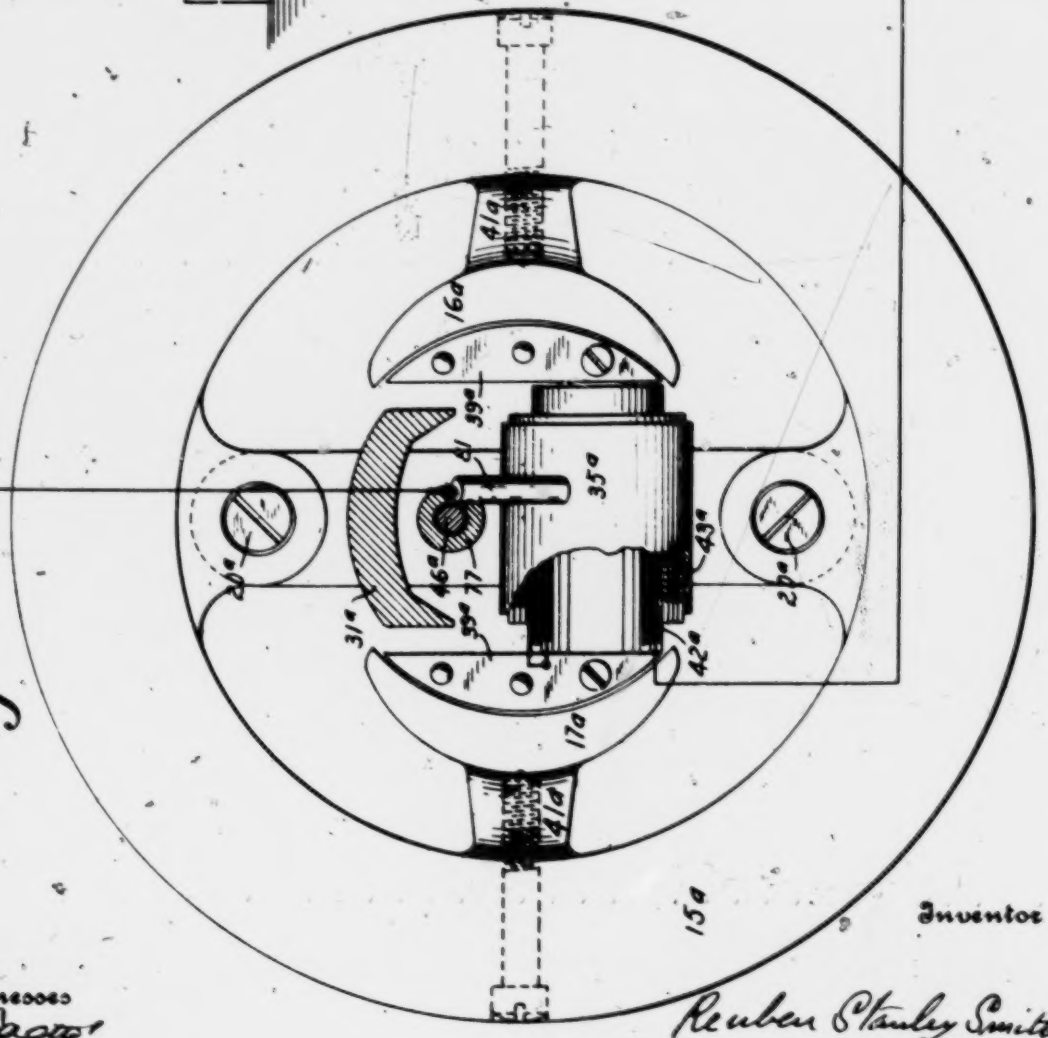


Fig. 4



Witnesses

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R. S. SMITH.
MAGNETO GENERATOR.
APPLICATION FILED SEPT. 2, 1916.

1,291,216.

Patented Jan. 14, 1919.

5 SHEETS-SHEET 5.

Fig. 6.

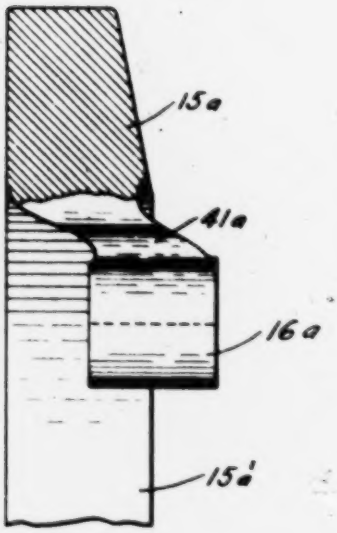
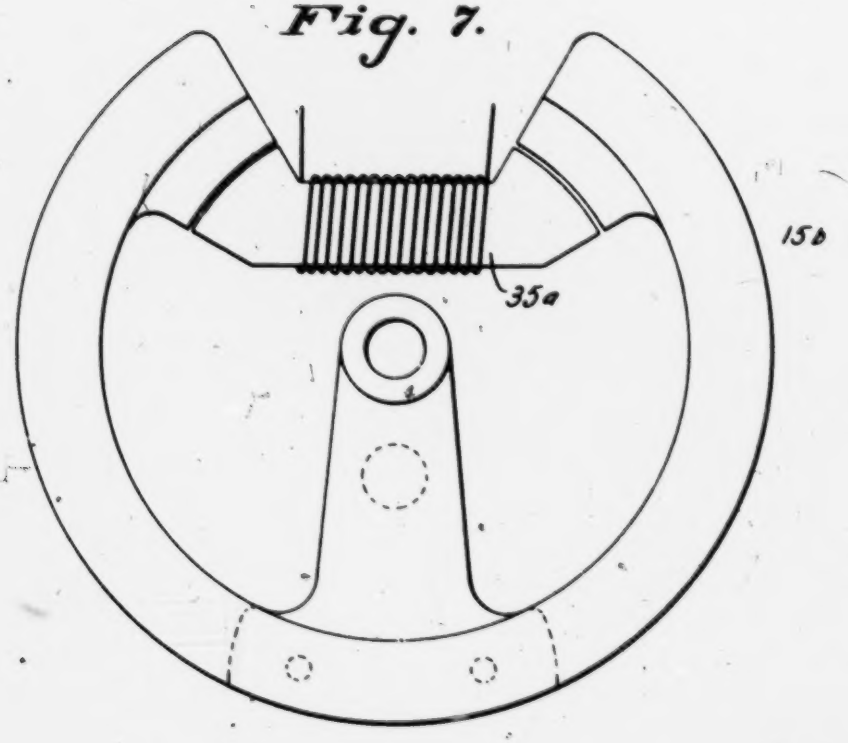


Fig. 7.



Witnesses
[illegible]
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UNITED STATES PATENT OFFICE.

REUBEN STANLEY SMITH, OF MILWAUKEE, WISCONSIN.

MAGNETO-GENERATOR.

1,291,216. Specification of Letters Patent. Patented Jan. 14, 1919.

Application filed September 2, 1916. Serial No. 118,177.

To all whom it may concern:

Be it known that I, REUBEN STANLEY SMITH, citizen of the United States, residing at Milwaukee, county of Milwaukee, and State of Wisconsin, have invented new and useful Improvements in Magneto-Generators, of which the following is a specification.

My invention relates to improvements in magneto generators, with particular reference to generators of that type in which the field revolves about a stationary armature.

Magneto generators of this type are usually embodied in small units in which it is greatly desirable that all of the parts should be compact, durable, and inexpensive. The object of my invention is therefore to not only secure these characteristics to the fullest possible extent but to also eliminate all unnecessary weight and to secure increased reliability in operation.

I propose to attain these objects in part by employing a circular field magnet composed of a continuous ring of permanently magnetic material, having interior polar projections on diametrically opposite sides thereof, (either integrally formed or otherwise), and supporting this ring directly from a set of fork arms connected with the crank shaft of the driving motor, with the arms secured to the ring substantially midway between the polar projections. The ring is magnetized to establish or constitute these projections as the poles and therefore the middle points between these projections are the neutral points to which the supporting arms may be secured without disturbing or weakening the magnetic field. By employing an integral continuous ring, the rotary member is better able to resist the strains developed by centrifugal force, and I therefore prefer it, although my invention contemplates also the use of a ring divided into segments having their ends secured to the pole pieces if desired. The continuous ring is also less expensive, particularly if the polar projections are integral.

I also propose to provide a form of construction in which a stationary armature may be supported from the engine frame and this support utilized to provide an end bearing for the crank shaft, said support extending through the rotary field ring in such a manner as to leave room for a stationary armature and so arranged as to avoid any impairment of energy such as might result from diversion of the lines of force, or the development of electrical currents in the support. By providing an extension of the crank casing with a bracket arm projecting around the rotating field and through the ring from the side opposite that at which the crank is located, I am enabled to bring the generator into close proximity to the crank and to produce a compact, well balanced and durable structure, reducing the number of parts and cost of manufacture to a minimum.

I also propose to secure increased reliability by providing a circuit breaking mechanism which is located and operated within an inclosure which not only excludes dust, oil, or other foreign matter from the contacts, but also protects the parts from injury. This feature is important for large units but it is also of especial importance for small units and particularly so where my invention is applied to motor driven vehicles or other portable devices.

In the drawings—

Figure 1 is a side elevation of an internal combustion engine structure with portions of the casing broken away in vertival section to expose the operating parts of my improved magneto generator.

Fig. 2 is a front elevation, partly in vertical section, drawn generally to a plane which includes the longitudinal axis of the crank shaft, the latter, however, being illustrated in full.

Fig. 3 is a detail view in vertical section exposing the crank shaft, and the connecting bolts of the field ring, and showing a modified form of construction.

Fig. 4 is a diagram of the same showing the relation of the armature to the field ring and spark plug and also showing the supporting arm of the crank shaft bearing ring in cross section.

Fig. 5 is a detail view of the outer face of the armature supporting cap showing the circuit breaker.

Fig. 6 is a fragmentary view of the field and one polar projection showing the latter in its offset relation to the ring.

Fig. 7 is a detail showing a modified field magnet.

Like parts are identified by the same reference characters throughout the several views.

Figs. 1 and 2 show my invention as applied to a four cycle internal combustion en-

gine of which 1 is the cylinder, 2 the crank shaft, 3 the pitman rod, 4 and 5 the cam shaft and cam, respectively, for actuating the exhaust valve, 6 the valve actuating rod and 7 and 8 the gear members for transmitting motion from the crank shaft to the cam shaft.

The crank shaft 2 is provided with a set of arms 10 to support the magnetic field ring. These arms are preferably elbowed and comprise integral extensions of the crank 12 and the oppositely disposed balancing arm 13. Being formed of steel, they are adapted to rigidly support a magnetic ring 15 in close proximity to the crank, but slightly offset longitudinally. The ring 15 is continuous and is provided with interior polar projections 16 and 17. The magnetic circuit is indicated by the arrows. I have discovered that it is not necessary to employ brass rings or other non-magnetic supports with segmental magnets mounted therein as has heretofore been customary, for if the continuous ring is so magnetized as to establish the poles in the projections 16 and 17, the portions of the ring midway between these poles are magnetically neutral, and the bolts 20 may be passed through these neutral points and the ring secured directly to the steel shaft arms without affecting the magnetic field. The ring being integral, it is also adapted, in itself, to perform the function of a fly wheel.

The crank case 25 has a cylindrical extension 26 provided with a removable disk shaped end wall 27, the latter being preferably centrally apertured and provided with a removable cap 28. The end wall 27 is directly bolted at 29 to an annular flange 30 on the extension 26. An arm 31 extends from the end wall 27 inwardly toward the crank shaft and supports a ring 32 at its inner end which provides a bearing for the tapered end 11 of the crank shaft, anti-friction balls or rollers 33 being preferably employed. A single arm is preferably employed in order to avoid the development of induced currents in the support or a diversion of the lines of magnetic force.

A stationary armature 35 is supported from the cap 28 by bolts or rivets 37 which are threaded or secured into the armature heads 39 as shown. The armature core is preferably offset from the center line between the head pieces 39 whereby space is provided at one side of the core and its winding to allow the arm 31 to pass between these parts and the circular path of the field pole pieces or projections 16 and 17. The armature being wholly supported from the cap 28, it is obvious that by removing the bolts 40, which connect this cap to end wall 27, the armature may be removed with the cap without disturbing any other portion of the mechanism.

It will be observed that the segmental portions of the polar projections 16 and 17 are connected with the ring 15 by neck portions 41. But the neck portions are located near the rear ends of the segments, *i. e.* near that end which is last to leave the armature head, whereby the magnetic field will be intensified and the lines of force will be concentrated in the shortest possible path at the time of breaking the circuit.

The general arrangement of the circuit conductors including the primary and secondary armature windings 42 and 43, is similar to that adopted in ordinary practice, but the circuit breaker is constructed and operated as follows. The circuit breaker operating lever 45 is pivoted to the casing at 46 and has an arm provided with head 47 interposed between the cam 5 and valve actuating rod 6 which operates the exhaust valve of the engine. The other end of this lever 45 is in a position to engage and actuate a circuit breaking pin 50 supported from the crank casing by a resilient diaphragm 51. The pin 50 extends through and is clamped to this diaphragm at 52. The upper end of the pin also projects through aperture 53 in a removable cap nut 54 forming a part of the wall of the casing, the upper end of the pin being in position to engage and actuate a resilient circuit closing arm 57 and thereby raise its terminal electrode 57 out of normal position of contact with the fixed terminal 58, thereby breaking the primary circuit of the armature. A dust tight casing 60, preferably having the form of an inverted cup, is secured to a projecting tubular boss 61 on the crank casing, the cap nut 54 being screwed to the interior wall of said boss. The casing 60, the boss 61, and the diaphragm 51 form an oil tight chamber in which cap nut 54, the upper end of the circuit breaking pin 50, the resilient arm 56, and contact members 57 and 58 are located. It will be observed that the diaphragm 51 is clamped between cap nut 54 and the interior annular shoulder 65 formed on the wall of the crank casing at the base of the boss 60. Therefore, by removing casing member 61, access may be had to the contact terminals, after which cap nut 54 may be removed to permit removal of diaphragm 51 and pin 50.

The head 47 of lever 45 is held to the cam 5 by the spring actuated valve rod 6. The cam holds the lever 45 in actuating relation to the pin 50 during all stages of cam revolution except during the short interval when head 47 registers with and enters cam depression 57, at which time the lever head 47 is depressed sufficiently under downward pressure exerted by valve rod 6 to allow pin 50 to move downwardly until arm 56 reaches circuit closing position, with members 57 and 58 in contact. This closes the primary circuit of the magneto, and this circuit is

again broken by the cam preparatory to a reversal of the magnetic flux. Sufficient current will thus be induced in the secondary winding to operate a jump spark igniter in the usual manner, the engine cylinder being provided with an ordinary igniter plug at 70.

In the modification shown in Figs. 3, 4, and 5, the same reference characters are applied to the corresponding parts as in Figs. 1 and 2 but with the letter a added. In this construction, it will be observed that a balancing arm 13ª is employed on only one leg of the crank 12ª; also that instead of the elbowed arms 10, shown in Fig. 2, I have provided the magnetic ring 15ª with projecting spacing studs 10ª located at the neutral points and through which the connecting bolts 20ª may pass. The ends of the spacing studs abut directly against the crank and the spacing arm 13ª, respectively.

The magnetic ring 15ª is a complete or continuous ring and, as in Figs. 1 and 2, it requires no brass or other nonmagnetic mounting either to support it against centrifugal force, or to connect it with the actuating shaft. The polar projections 16ª and 17ª have necks 41ª detachably connected with the ring. The polar projections are segmental and the neck portions 41ª are centrally located instead of being located near one end of the segment as illustrated in Fig. 1.

The principal distinction, however, between the construction illustrated in Figs. 3, 4, and 5 and that illustrated in Figs. 1 and 2, is in the structure and arrangement of the circuit breaker. It will be observed that a cam 5ª is mounted upon the inclosed end of the crank shaft shown in Fig. 3, this cam being mounted upon the axial projecting portion of the shaft extending beyond the tapered portion 11ª which forms a cone having bearing rollers 33ª. A circuit breaking arm 56ª (Fig. 5) is mounted upon the outer face of the cap plate 28ª and carries a contact member 57ª in position for contact with the terminal electrode 58ª. Motion is transmitted periodically from the cam 5ª to actuate the resilient circuit breaking arm 56ª through the arm 45ª rocking shaft or rod 46ª and arm 75, the latter being located on the outer end of the rocking shaft 46ª in a position to engage and actuate a circuit breaking arm 56ª as best illustrated in Fig. 5. The rocking shaft 46ª has its bearings in arm 77 which projects inwardly from the cap 28ª underneath arm 31ª. The coiled spring 78 (Fig. 3) is arranged to oscilliate the shaft 46ª in a direction to retract arm 75 from the circuit breaking arm 56ª and also in a direction to hold the shaft arm 45ª in contact with the cam surface. It also holds rock shaft 46ª with its conically tapered shoulder 79 against the correspondingly tapered seat at the inner end of arm 77. The cam projection will periodically actuate the arm 45ª in the opposite direction, this motion being transmitted to cause arm 75 to swing into contact with and actuate arm 56ª to circuit breaking position. 80 is a condenser also mounted upon the cap plate 28ª, this being inclosed with circuit breaker and arm 75 by housing 60ª screwed to the projecting flange 61ª to form an oil tight, dust-excluding casing. The secondary armature coil 43ª has one end connected with the spark plug 70 by contacting wire extending through the conduit members 81 and 82. This conduit passes through supporting sleeve members 83 and 84, having screw threaded connection with each other and adapted to contain coupling fuse at 86.

The principle of operation of the modified structure is the same as that of the structure shown in Figs. 1 and 2, but in the construction illustrated in Figs. 3, 4, and 5, only the alternate igniting sparks will be utilized when connected with a four-cycle engine, since the circuit will be broken once for each revolution of the crank shaft, but this involves merely the waste of the intermediate sparks and the loss of energy is negligible. It will also be observed that in the structure shown in Fig. 3, the circuit breaker, together with the rocking shaft 46ª and its arms 45ª and 75, may be removed with the cap 28ª which also supports the armature. By removing the housing 60ª, access may be readily had to all portions of the circuit breaker and also to the armature when the cap 28ª is removed. The bearing ring 32ª together with the cam 5ª, the bearing rollers 33ª, etc., will all be exposed through the opening in the casing which is normally covered by said cap 28ª, but owing to the fact that the armature and the circuit breaking mechanism are removed with the cap, it is obvious that this portion of the crank chamber will be unobstructed and access to the crank shaft bearing will therefore be facilitated. The outer face of the cam number 5ª is beveled or conically tapered as shown at 88, whereby when the cap 28ª is replaced, arm 45ª will be pushed outwardly until it moves upon the curved outer surface of the cam.

In Fig. 3, the cap 28ª is shown adjustably mounted on the casing wall and held by a set screw 40ª. This allows a turning adjustment of the armature. Comparing Fig. 3 with Fig. 6, it will be observed that the segmental polar projections 16ª and 17ª are offset from the ring 15ª, whereby they travel a circular path concentric with the circle which includes the armature heads.

Referring to Fig. 7, it will be observed that I have illustrated a field ring 15ᵇ of what may be called the horse-shoe type, the ring being a split ring with polar projections on opposite sides of the gap, adapted

for simultaneous registry with the respective armature heads during the rotation of the ring. In this construction, the neutral point is diametrically opposite the gap in the ring and therefore the ring will be attached at this point to the crank. In this form of construction, the ring will have only one point of support instead of two, as illustrated in the other views, and this connection may be made either with the crank or the balancing arm.

I claim—

1. A magneto generator including the combination with a rotary shaft, of a ring composed of magnetic material provided with oppositely disposed polar projections and adapted by its continuity to resist centrifugal strains and to perform the function of a fly wheel, arms on the shaft directly connecting the shaft with the ring at points substantially midway between the polar projections, and adapted to support and actuate the ring, and an armature located in current generating relation to the ring.

2. The combination with a driving motor crank shaft, of a fly wheel wholly composed of magnetic materi l and having its peripheral portion connected at its magnetically neutral points with the crank shaft, segmental pole pieces connected with the wheel rim substantially midway between said neutral points, and a relatively stationary current generating armature having its heads in proximity to the circle described by said pole pieces.

3. The combination with a driving motor crank shaft, of a rotary annular field magnet supported from one end portion thereof, a stationary support, a bearing member for the crank shaft, an arm connected with said support and projecting inwardly through the space encircled by the field magnet and connected with the bearing member to support the latter, and a current generating armature in operative relation to the field magnet.

4. In a magneto generator the combination with an armature, of a unitary homogeneous rotor, comprising a shaft, shaft arms, and a field magnet, all of magnetizable material, the field magnet having permanently established magnetic poles, and being secured directly to the shaft arms at its magnetically neutral points and supported thereby in current generating relation to the armature.

5. A magneto generator including a rotor wholly composed of magnetizable material and comprising a shaft and a field magnet having permanently established magnetic poles, and wholly supported from the shaft through a magnetically neutral point in the field.

6. The combination with a driving motor crank shaft, of a rotary annular field magnet secured to one end portion thereof, an inclosing housing provided with an end cap and a current generating armature secured to said cap and supported thereby within the circle described by the field magnet.

7. The combination with a driving motor crank shaft, of a rotary annular field magnet secured to one end portion thereof, of an inclosing housing therefor having a removable end wall provided with an aperture, an arm secured to said wall and projecting inwardly through the annular field magnet, a bearing member for the crank shaft, carried by said arm, a removable cap for the end wall aperture and an armature supported by said cap within the rotary field.

8. In a magneto generator the combination with a permanently magnetic rotary field having definitely fixed poles, of a relatively stationary armature in current generating relation to the field, and a magnetizable support adapted to actuate the field through a neutral point substantially midway between its poles.

9. In a magneto generator, the combination with an actuating shaft, of a rotary annular field ring provided with interiorly projecting pole pieces, an armature having segmental heads in proximity to the circle described by said pole pieces at diametrically opposite points and having the axis of its core and winding therefor offset from the center of said ring, and a bearing for said shaft having a supporting arm connected with a relatively stationary support and projecting through the space between the armature winding and the ring and between the armature heads.

10. In a magneto generator, the combination of a rotary annular field ring having interiorly projecting segmental pole pieces, a current generating armature located within the circle described by the pole pieces, each pole piece being supported from the field ring by a neck portion located near the rear end of the segment, and a circuit breaker arranged to break the circuit of the armature when the magnetic field is substantially at maximum intensity.

11. The combination with an internal combustion engine provided with an igniter plug and crank shaft, of a permanently magnetic field ring secured by an arm of magnetizable material at a magnetically neutral point to the crank shaft, and an armature supported from the engine frame within the magnetic field of said ring and having a winding operatively connected to the igniter plug.

12. The combination with an internal combustion engine provided with an igniter and a crank shaft provided with a crank and an oppositely projecting balancing side arm, of a permanently magnetic field ring secured to said balancing arm and one side

arm of the crank, interior polar projections on said ring substantially mid-way between said points of connection, and a relatively stationary armature within the magnetic field of the ring and operatively connected with the igniter.

13. The combination with an internal combustion engine provided with an igniter and a crank shaft provided with a crank and an oppositely projecting balancing side arm, of a permanently magnetic field ring secured to said balancing arm and one side arm of the crank, interior polar projections on said ring substantially mid-way between said points of connection, and a relatively stationary armature within the magnetic field of the ring and operatively connected with the igniter, said armature having a plurality of windings, one being in circuit with the igniter, and the other constituting a primary circuit and provided with means controlled by the engine for periodically breaking such circuit.

14. The combination with an internal combustion engine, having a crank shaft provided with a balancing arm, of a magnetic field ring secured at its neutral points to said arm and one arm of the crank respectively, a housing for said ring, having a projection extending therethrough, a bearing for the crank shaft carried by said housing projection, an armature detachably supported from the housing within the ring, and an igniter and a circuit breaker each in circuit with said armature.

15. The combination with a driving shaft, of a magnetic field ring supported therefrom, an inclosing casing for the ring and shaft provided with a removable end cap, and a relatively stationary armature supported by the cap.

16. In a magneto generator, provided with an inclosing casing, the combination with such casing of a removable wall portion and an armature secured thereto.

17. In a magneto generator provided with an inclosing casing, having a removable portion, an armature secured to said removable portion of the casing and circuit breaking mechanism also secured thereto and removable therewith.

18. In a magneto generator the combination with a field magnet, of a support composed of magnetizable material directly connected with the field magnet at a magnetically neutral point.

19. An integrally continuous ring connected with a rotary support and adapted to serve as a fly wheel, said ring being magnetized to constitute poles on opposite sides of the connection with the support, said point of connection constituting a magnetically neutral point.

20. The combination with a driving motor crank shaft and supports therefor, of an annular field magnet having permanently established magnetic poles and carried by and rotating with the crank shaft, the crank shaft and the magnet being connected at a neutral point of the latter, and a current generating armature in operative relation to the field magnet.

In testimony whereof I affix my signature in the presence of two witnesses.

REUBEN STANLEY SMITH.

Witnesses:

LAWRENCE C. WHEELER,

J. J. STAMM.

A. ERICKSON.

IGNITION APPARATUS.

APPLICATION FILED NOV. 19, 1919.

1,401,058. Patented Dec. 20, 1921.

2 SHEETS—SHEET 1.

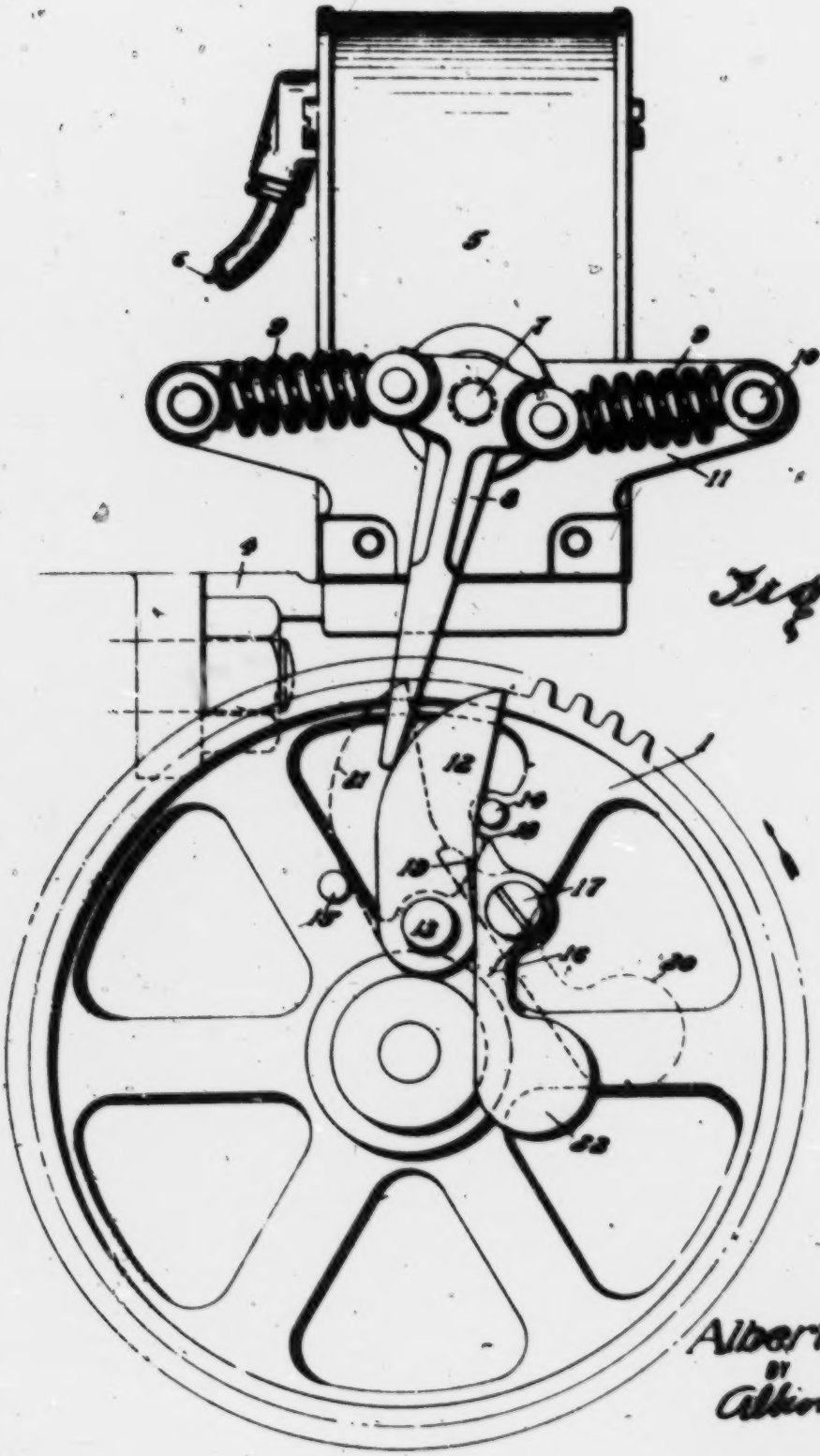

Fig-1

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BY

Albion D. J. Libby

ATTORNEY

P-153

A. ERICKSON.

IGNITION APPARATUS.

APPLICATION FILED NOV. 19, 1919.

1,401,058.

Patented Dec. 20, 1921.

2 SHEETS—SHEET 2.

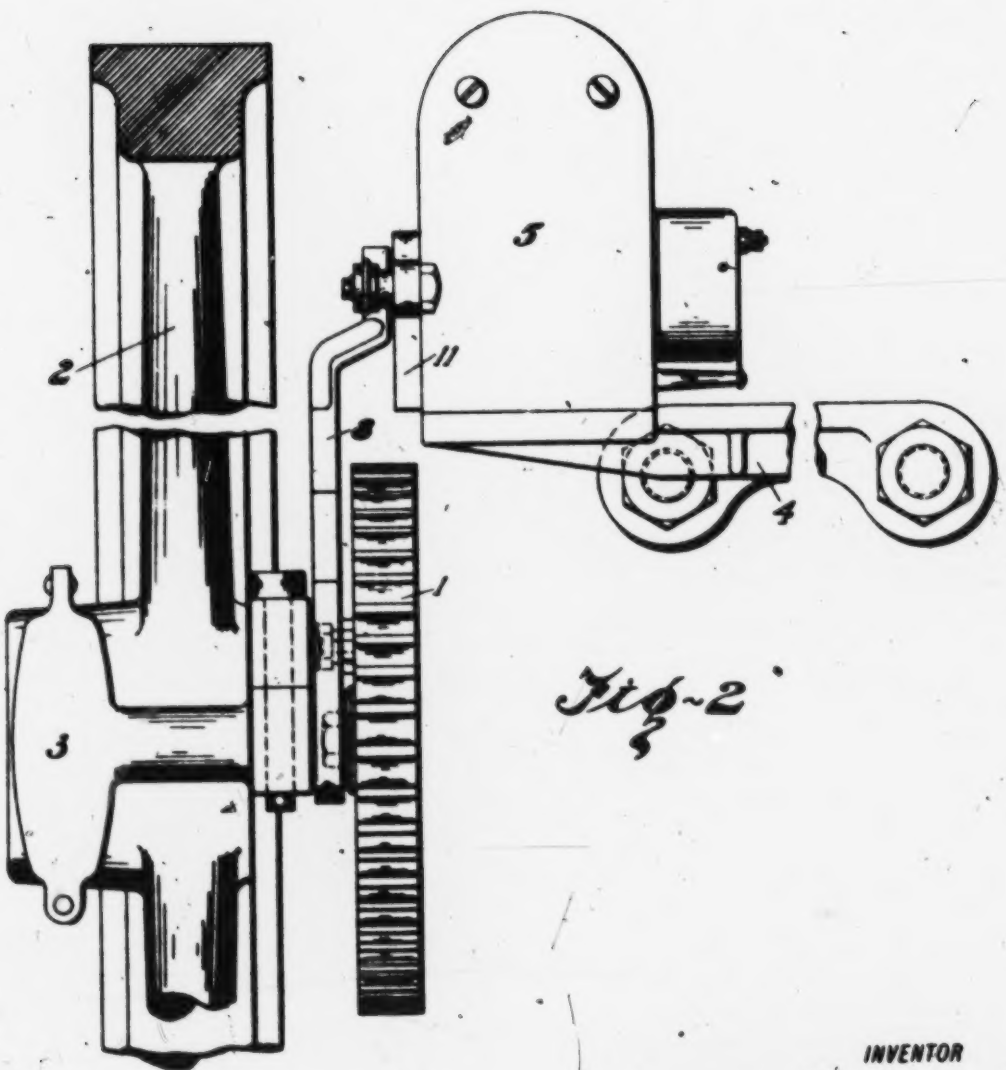

Fig-2

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Albion F. Libby

ATTORNEY

UNITED STATES PATENT OFFICE.

ALBERT ERICKSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO SPLITDORF ELECTRICAL COMPANY, OF NEWARK, NEW JERSEY.

IGNITION APPARATUS.

1,401,058. Specification of Letters Patent. Patented Dec. 20, 1921.

Application filed November 19, 1919. Serial No. 339,081.

To all whom it may concern:

Be it known that I, ALBERT ERICKSON, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented certain new and useful Improvements in Ignition Apparatus, of which the following is a description, reference being had to the accompanying drawing and to the figures of reference marked thereon.

My invention relates to ignition apparatus in which the ignition generator is of the oscillating type and which supplies current to electrodes in an engine cylinder, one of which is adapted to be moved to introduce a spark gap substantially co-incident with the time of generation of maximum current by the ignition generator.

It is the principal object of my invention to provide a generator which will deliver its maximum current at a suitable time with reference to the position of the engine piston. In magnetos of the oscillating type with which I am familiar no good means have been provided for advancing the time of producing maximum current from the generator after the engine has been started. It is the usual practice to start a stationary engine with the spark occurring beyond "dead" center; that is to say, in retard position.

Certain attempts have been made to shift the position of the spark after the engine has been started manually but on account of the method of connection of an oscillating type magneto to the engine, it is not easy to do this automatically. It is, therefore, another object of my invention to provide a simple, inexpensive means of advancing the spark automatically after the engine has been started.

Other and further objects will be apparent to one skilled in the art after a study of the specification and the annexed drawings, wherein—

Figure 1 is a view of a portion of the engine showing an engine driven member in operative relationship to the ignition generator.

Fig. 2 is a partial view of the ignition generator and certain engine members.

In the drawings, 1 illustrates an engine driven member which, in the case at hand, is the cam shaft gear mounted adjacent the flywheel 2, 3 being a governor associated with the parts 1 and 2 for governing the throttle of the engine. Carried on a bracket 4 is an ignition generator 5. An electrical conductor 6 extends from generator 5 to an insulated electrode in the engine cylinder. These electrodes are not shown as they form no part of my invention and are well understood in their construction and operation and will, therefore, not be referred to in detail herein. The generator 5 has a shaft 7 which operates a rotatable member for the generation of electrical current. Fastened to the shaft 7 is a trip lever 8. Associated with the trip lever 8 are springs 9, having one end attached to an arm of the trip lever, and the other end attached to a suitable bearing 10, preferably carried on a bracket 11 fastened to the ignition generator. Carried on the engine driven member 1 is a cam member 12, the same being preferably supported on a pivotal bearing 13. A stop pin 14 limits the movement of the member 12 in one direction and the pin 15 limits its movement in the opposite direction. A pawl 16 is pivotally carried on the member 1 by pivot screw 17. The pawl 16 has a nose 18 adapted to engage the notch 19 in the member 12 when the pawl has moved to the dotted position indicated at 20, the member 12 then being in the position shown by dotted lines 21.

In operation, when the engine is being started the member 12 is in the position shown in full lines in Fig. 1 and as the member 1 turns in the direction of the arrow, the cam member 12 will act on the trip lever 8 to move the rotatable member of the generator 5 to a position which will tension the springs 9 and when the rotation of member 1 has proceeded far enough the trip member 8 will slip over the nose of the cam 12 and the springs 9 will rapidly return the rotatable member of the generator 5 to normal position, generating a relatively heavy current in the winding of the generator which current will be conveyed by conductor 6 to the spark plug or sparking electrodes that are operated by suitable engine mechanism (not shown) when a low tension generator is used. As soon as the engine comes up to its normal running speed the pawl 16, due to its weighted end 22, will move out to the position shown in dotted lines 20 pushing the cam member 12 to the position shown in dotted lines 21 and the nose 18

will engage the notch 19 thereby holding the cam member 12 in advanced position until the engine speed has dropped to a point considerably below normal.

It will be seen that I have provided a very simple and inexpensive mechanism to do this work and it will be apparent that various changes may be made in the details without departing from the spirit of my invention and the scope of the appended claims.

Having thus described my invention, what I claim is:—

1. An ignition generator for internal combustion engines, having a rotatable member for the generation of electric current, an oscillatory member secured thereto, rotary non-oscillatory means on the engine for intermittently engaging and moving said oscillatory member through a portion of a revolution and then releasing it, means for returning the oscillatory member to normal position after said release occurs, and means including a weighted pawl on said engine for automatically advancing said engine cooperating means for the purpose described.

2. An ignition generator for internal combustion engines, having a rotatable member for the generation of electric current, an oscillatory member secured thereto, rotary non-oscillatory means on the engine for intermittently moving said oscillatory member through a portion of a revolution and then releasing it, means for returning the oscillatory member to normal position after said release occurs, and means including a weighted pawl on said engine for automatically advancing said engine coöperating means and holding said coöperating means in advanced position during normal running of the engine.

3. In combination an ignition generator for internal combustion engines having a rotatable member for the generation of electric current, an oscillatory trip lever fastened to said rotatable member for rotating the same, a rotary non-oscillatory engine driven member, a member for intermittently engaging and actuating the trip lever carried on said engine driven member, spring associated with said lever for returning the trip lever and rotatable member after being actuated by said actuating member, and a weighted pawl operated by the engine for moving said actuating member to advanced position as described.

4. In combination an ignition generator for internal combustion engines having a rotatable member for the generation of electric current, a trip lever fastened to said rotatable member for rotating the same, an engine driven member, a cam for actuating the trip lever pivotally mounted on the engine driven member, springs associated with said trip lever set under tension by movement thereof, for quickly returning said trip lever and rotatable member after said trip lever has been released by said cam and a pawl carried on the engine member responsive to centrifugal force for moving the cam member to advanced position after the engine has been started.

5. In combination an ignition generator for internal combustion engines having a rotatable member for the generation of electric current, a trip lever fastened to said rotatable member for rotating the same, an engine driven member, a cam for actuating the trip lever pivotally mounted on the engine driven member, springs associated with said trip lever set under tension by movement thereof, for quickly returning said trip lever and rotatable member after said trip lever has been released by said cam and a pawl pivotally mounted on the engine member responsive to centrifugal force provided with means for automatically moving the cam to advance position after the engine has been started and for permitting the cam to return to retard position at a predetermined low speed of the engine.

6. In an ignition system, the combination of, an oscillating type of electric generator comprising a trip lever attached to the rotatable member of the generator and having springs for producing a quick impulse of the rotatable member after displacement and release thereof by the trip finger, a rotary non-oscillatory engine operated cam for actuating the trip lever and means responsive to the speed of the engine for advancing and holding the cam in an advance position during normal running of the engine.

7. In combination, an ignition generator for internal combustion engines having a rotatable member for the generation of electric current, a trip lever fastened to said rotatable member for rotating the same, an engine driven member, a cam for actuating the trip lever pivotally mounted on the engine driven member, springs associated with said trip lever set under tension by movement thereof, for quickly returning said trip lever and rotatable member after said trip lever has been released by said cam, a centrifugally responsive pawl pivotally mounted on the engine member and coöperative means on the pawl and cam member for moving the cam member to spark advanced position and for holding the cam member in such position, when the engine driven member has attained a predetermined angular velocity.

In testimony whereof, I affix my signature.

ALBERT ERICKSON.

P. BROWN.

ACTUATING MECHANISM FOR MAGNETOS.

APPLICATION FILED JUNE 25, 1920.

1,427,718. Patented Aug. 29, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

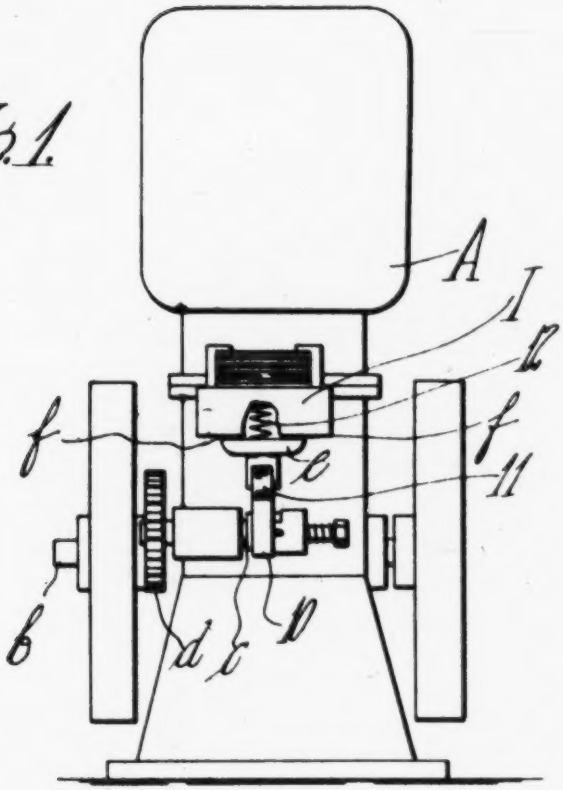


Fig. 2.

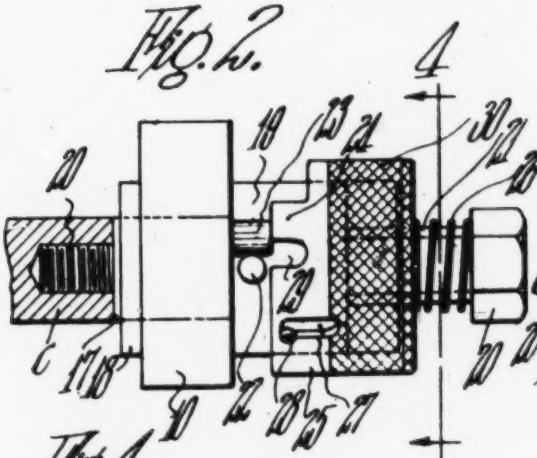


Fig. 3.

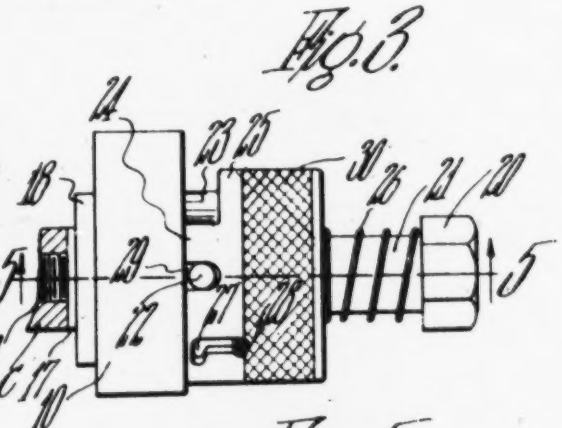


Fig. 4.

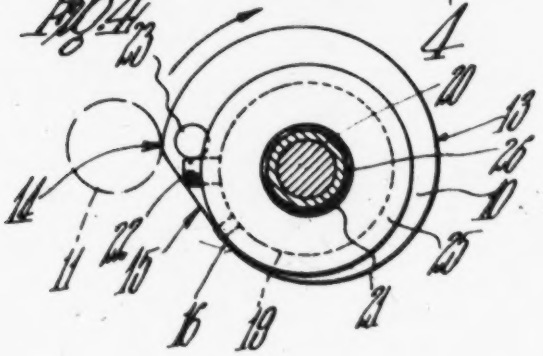
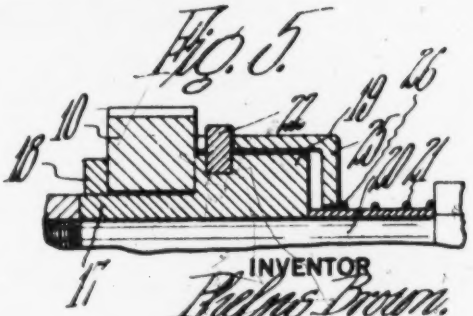


Fig. 5.



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ACTUATING MECHANISM FOR MAGNETOS.

APPLICATION FILED JUNE 25, 1920.

1,427,718.

Patented Aug. 29, 1922.

2 SHEETS—SHEET 2.

Fig. 6.

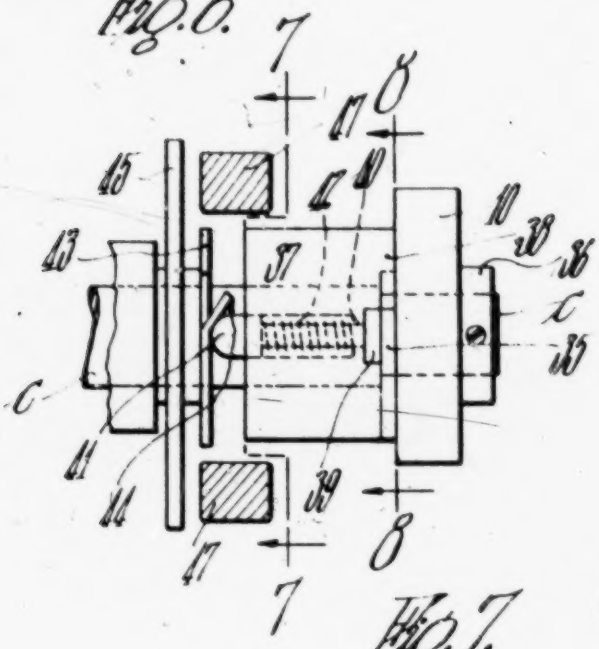


Fig. 8.

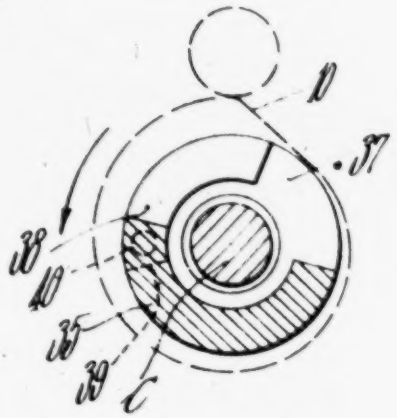
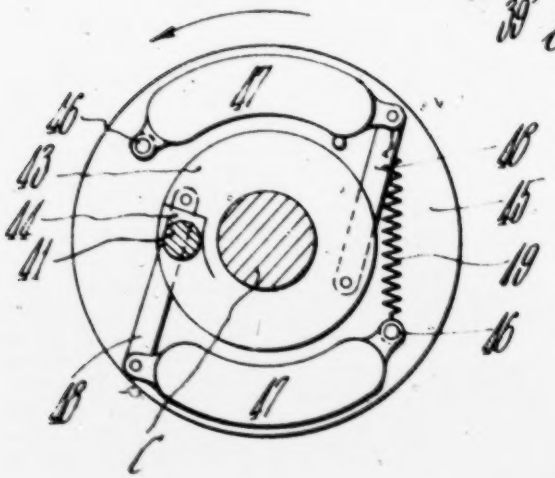


Fig. 7.



INVENTOR

Phelps Brown.

BY Chapin Neal

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UNITED STATES PATENT OFFICE.

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ACTUATING MECHANISM FOR MAGNETOS.

1,427,718. Specification of Letters Patent. Patented Aug. 29, 1922.

Application filed June 25, 1920. Serial No. 391,712.

To all whom it may concern:

Be it known that J. PHELPS BROWN, a citizen of the United States, residing at Springfield, in the county of Hampden and State of Massachusetts, have invented new and useful Improvements in Actuating Mechanism for Magnetos, of which the following is a specification.

This invention relates to the driving or actuating mechanism of magnetos and, more particularly, to magnetos of the reciprocatory armature type.

While the invention is capable of general application, it finds one advantageous use in magnetos of the general character disclosed in U. S. Letters Patent No. 1,307,343, granted to me on June 24, 1919. The invention disclosed in such patent is directed, among other things, to improved means for moving the armature to and from the cores of the magnetos, which means are characterized in that they eliminate, to a large degree, the noisiness of operation heretofore incident to magnetos of the reciprocatory armature type. That is to say, the actuating means is designed with a view to avoiding the noise-producing sharp blows and impingements hitherto common in, and considered essential to the commercial success of, magnetos of this particular character. This invention is directed, among other things, to the same general problem.

An object of this invention is to provide improved driving means, in the nature of a cam, for moving the armature toward the cores of the magneto and subsequently releasing it for more rapid movement away from the cores, characterized in that the cam permits the armature to descend with relative rapidity but without the usual attending noise.

According to this object, the cam is of such contour as to gradually move the armature in one direction but is not, as is usual, provided with a sharp "let off" portion which allows the armature, and the cam follower which it engages, to fall freely and acquire considerable momentum before its fall is checked by a noise producing impingement. Rather, the cam has a relatively gradual fall, like an inclined plane, and is permitted to slip on its driving shaft in the direction of rotation. The arrangement is such that, after the high point of the cam passes under the cam follower, the pressure of the latter on the inclined plane forces the cam ahead very rapidly on its driving shaft and thereby accomplishes the desired relatively rapid descent of the cam follower without the undesirable noise usually incident to the rapid descent.

More particularly, it is an object of the invention to provide a cam, of the character described, which is loosely mounted on its drive shaft and can be driven by the engagement of an abutment on one with an abutment on the other, whereby the cam may be moved ahead relatively to its drive shaft and the abutments separated by pressure of the cam follower on the "fall" portion of the cam.

Another object of the invention is to provide in an actuating mechanism of the general type described, means for advancing the cam on its drive shaft for timing purposes, such means being in the character of a spacer which may be manually interposed between the described abutments with rapidity and convenience, even while the cam is in motion, or automatically, as desired.

Other objects and advantages will appear in the following description and in the illustrative embodiment of the invention in the accompanying drawings, in which.—

Fig. 1 is an elevational view of a magneto mounted on an explosive engine and driven therefrom by mechanism embodying the invention;

Figs. 2 and 3 are enlarged elevational views of the actuating mechanism, Fig. 3 showing the spacing device interposed between the coacting abutments to vary the "timing" of the cam;

Fig. 4 is a cross sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a longitudinal section taken on the line 5—5 of Fig. 3;

Fig. 6 is a fragmentary elevational view, partly in section, illustrative of a modification; and

Figs. 7 and 8 are cross sectional views taken on the lines 7—7 and 8—8, respectively, of Fig. 6.

Referring to these drawings: A indicates conventionally an explosive or internal combustion engine, having a crank-shaft *b* and another shaft *c* which is driven, as by gears *d*, from shaft *b* at appropriate speed with relation to the frequency at which sparks are to be produced by the magneto for ignition purposes. The magneto, indicated conventionally at I, may be of any suitable type in which an armature *e* is movable to and from a core, or cores, *f* to vary the reluctance of a magnetic circuit. The magneto may, for example, be of the type disclosed in the patent above alluded to. For the present purposes, it will suffice to state that the armature *e* is gradually moved toward cores *f*, as by a cam 10, and cam follower 11, and is later released for movement with relative rapidity away from the cores *f*, at which time the ignition spark is generated. As illustrated, the release of the cam follower 11 occurs once on each revolution of shaft *c*, although the frequency of release relatively to the revolutions of shaft *c* may be varied, as desired. The movement of the cam follower 11 away from the cores may be accomplished by any suitable means capable of exerting sufficient pressure on cam 10 to move it forwardly on its drive shaft in a manner later to be described. A spring 12, for example, may be utilized to force the follower 11 toward cam 10 as indicated in Fig. 1 or the mechanism illustrated in the above-mentioned patent may be utilized for the same purpose.

The mechanism for controlling the movement of armature *e* will now de described with particular reference to Figs. 2 to 5 inclusive. The cam 10, as best shown in Fig. 4 is of the "edge" type and has its periphery formed to provide a gradual rise 13, which occupies the major portion of the periphery and terminates with the high part 14, and with a fall 15, which connects the part 14 with the low point 16 of the cam. The portion 15 is preferably a flat surface and, although of gradual slope, compared to the fall portion of the usual "let off" cam, is of considerably steeper slope than the rise 13. The cam 10 is intended to rotate in the direction of the arrow (although it is capable of being rotated in the opposite direction) and the portion 15 is so fashioned, as just described or otherwise, if desired, that a sufficient component of the pressure of the cam follower 11 upon it will be afforded to move the cam in the direction of its intended rotation, relatively to its driving shaft.

With this object in view, the cam 10 is mounted so as to be free to turn within limits relatively to its drive shaft *c*. As illustrated, the cam 10 is mounted to turn freely on a hub 17 and is held against axial displacement between a collar 18 suitably fixed thereto and a head 19 integrally formed with, or otherwise fixed to a, hub 17. The latter is fixed to shaft *c* in any suitable way as, for example, by a bolt 20 which passes axially through the hub and is threaded into shaft *c*. As illustrated, the head of bolt 20 does not directly abut the hub 17, but rather acts through the intermediary of a spacing sleeve 21 to clamp the hub against the end of shaft *c*. In order to drive the cam 10 from shaft *c*, or the hub 17 fixed thereto, interengageable abutments are provided one on the cam and one on the collar portion 19 of hub 17. Thus, a pin 22 is fixed to and projects radially outwards from collar 19 and a pin 23 is fixed to and projects axially outwards from an end face of cam 10 into the path of pin 22.

With the cam 10 travelling in the direction of the arrow (Fig. 4) and the follower 11 engaged with the "rise" 13, the pressure of the follower on the rise tends to turn the cam relatively to hub 17 in a direction opposite to the direction of rotation, whereby the pins 22 and 23 are held in engagement and the hub and cam rotate in synchronism until the follower reaches the high part 14 of the cam. When, however, the follower 11 rides onto the portion 15, its pressure, having a component in the direction of rotation of the drive shaft, forces the cam rapidly ahead on the drive shaft. The cam 10 thus moves ahead until the surface 15 becomes positioned at right angles to the line of pressure of the cam follower 11, at which time there is no force tending to move the cam in either direction. Consequently, the cam dwells in this position, until the pin 22 overtakes and engages the pin 23. Thus, a very rapid drop of the cam follower is permitted and this is accomplished without the usual attending noise. The follower never leaves engagement with the cam and thus there cannot be the noise incident to a subsequent re-engagement of these parts with impact of one upon the other, which occurs when one moving under momentum from a free fall is arrested by the other.

In order to provide for changing the angular position of the cam on shaft *c* to effect variations in timing, a spacer 24 is arranged to be interposed between pins 22 and 23 as shown in Fig. 3. The pins 22 and 23, when directly engaged as in Fig. 2, effect the release of the follower 11 at such time as to cause a retarded spark. These parts, when positioned as in Fig. 3, cause an advance in the time of the spark.

In order to conveniently interpose the spacer 24 to advance the spark while the

shaft *c* is in motion, it is formed as a part of a shell 25, which losely fits over the portion 19 of hub 17 and is capable of being moved angularly and axially within limits relatively thereto. To move the shell 25 axially, when released, a spring 26 is provided, which acts between the head of the bolt 20 and the head of the shell 25. A bayonet, or right angularly shaped, slot 27 is provided in the shell, into which slot a pin 28, fixed in collar 19 extends. Pin 28, when engaged in that portion of slot 27 which lies at right angles to the axis of the shell, prevents axial movement of the latter under the force of spring 26 and holds the shell and the spacer 24 in an inactive position, as shown in Fig. 2. The shell is further provided with a U-shaped recess 29 to receive pin 22, when the spacer 24 is interposed between the latter and pin 23. The shape of recess 29 is not particularly material, however, and it may be otherwise formed as long as it permits the shell 25 to move forwardly sufficiently to permit the interposition of spacer 24 between the pins 22 and 23. The shell 25, when turned sufficiently to bring pin 28 in line with that portion of slot 27 which is parallel to the axis of the shell, is likewise positioned that recess 29 is in line with pin 22. The shell 25 is preferably provided with a knurled portion 30, whereby it may be conveniently gripped manually.

Where it is desired to advance the spark automatically, I provide the slightly modified arrangement shown in Figs. 6, 7, and 8. The shaft *c*, as before, loosely carries the cam which is provided with an abutment 35 in the shape of an arcuate projection on a side face of the cam. The latter is held from endwise movement on shaft *c* between collars 36 and 37, both fixed thereon. The collar 37, on that face adjacent to the cam, carries an abutment 38, similar to and adapted for engagement by the abutment 35. The cam 10 is driven in the direction of the arrow by the engagement of the abutment 38 with abutment 35. During each revolution, cam 10 is forced ahead in the same manner as before, and the abutments 35 and 38 are separated. The spacer, for interposition between these abutments, consists of a "keystone" shaped member 39 which is fixed to a pin 40 slidably mounted in collar 37 for movement parallel to the axis of shaft *c*. Pin 40 has an enlarged rounded end 41 protruding from that end of the collar 37 remote from cam 10 and a spring 42 acting between this end 41 and a shoulder in the collar holds the spacer 39 retracted, as shown, in a recess in the collar and out of the path of the abutments 35 and 38.

For automatically moving the spacer 39, a ring 43 is loosely mounted on shaft *c* and carries a cam 44 which, when the ring is shifted around the shaft *c* and thus relatively shifted with respect to collar 37, will engage the end 41 and move spacer 39 into the path of the abutments. Ring 43 may be shifted by any suitable means, but I prefer to shift it automatically when the engine reaches a predetermined speed. To this end, a disc 45 is fixed to shaft *c* and on the disc and on opposite sides of shaft *c* are pivoted at 46 relatively heavy members 47. The free ends of these members are connected to disc 45 by means of links 48. A spring 49, connecting the pivot of one member 47 to the free end of the other, normally holds the members 47 in their inner positions and ring 43 in such position that pin 40 is not advanced by cam 44. When the engine reaches a predetermined speed, which may be gauged as desired, the members 47 tend to move outwardly by centrifugal force and shift ring 43 around shaft *c*. This shifting, of course, cannot take place until the abutments 35 and 38 separate but immediately that such separation occurs the ring 43 shifts and cam 44 moves the spacer 39 between the abutments and holds it thus positioned as long as the speed of the engine is maintained at or above the chosen predetermined speed.

In operation, the shell 25 is positioned, as shown in Fig. 2, on starting of the engine A, the cam 10 being so located on its drive shaft as to cause the production of a retarded spark from the magneto I. In the case of the device shown in Figs. 6 to 8, this is automatically accomplished. The cam operates the armature *e* of the magneto as already set forth in detail. After the engine has been started and it is desired to advance the spark, the shell 25 is momentarily lightly gripped sufficiently to cause pin 28 to move out of the "bayonet" portion of slot 27 and free the shell for axial movement, which occurs rapidly and automatically under the action of spring 29. The interposition of spacer 24 between the pins 22 and 23 occurs, of course, when the latter separate as the cam 10 is moved rapidly ahead on its drive shaft. The operation of the device shown in Figs. 6 to 8 has already been explained.

The invention has been disclosed herein for illustrative purposes, but the scope of the invention is defined by the appended claims rather than by the foregoing description.

What I claim is,—

1. In a magneto, a movable armature, an actuating cam, and a cam follower therefor, a driving member with relation to which the cam is free to turn, a device on the cam and a device on said member to drive the cam from the latter by abutment, and means forcing said follower against the cam; the latter having a part which, when engaged

by said follower, will, by the force of said means, move the cam ahead of its driving member and permit a rapid movement of the follower without disengagement from the cam.

2. In a magneto, a movable armature, an actuating cam therefor, a driving member with relation to which the cam is free to turn, a device on the cam and a device on said member to drive the cam from the latter by abutment, and means forcing said armature toward the cam, the cam having a part so inclined to the direction of pressure from the armature that pressure from the latter on such part will move the cam ahead relatively to its driving member.

3. In a magneto, a movable armature, an actuating cam for moving the armature in one direction and releasing it for movement in the other direction, means for moving the armature in the second direction, a driving member with relation to which the cam is free to turn, interengageable devices one on the cam and one on said member to drive the former from the latter, said cam having a surface for moving the armature in the first direction, and a second surface so inclined to the direction of pressure from the armature that the cam will be moved ahead of its driving member by the force that moves the armature in the second direction.

4. The combination, with a cam follower, of a cam for moving it in one direction and releasing it for movement in an opposite direction, a driving member with relation to which the cam is free to turn, and interengageable devices one on said cam and one on said member for driving the former from the latter, the contour of said cam for moving the follower in the first-named direction being such that a component of the pressure of the follower on the cam tends to hold said means in engagement, the contour of the cam for releasing the follower for movement in the other direction being such that the pressure of the follower moves the cam ahead relatively to the driving member in the direction of its rotation.

5. In a magneto, a movable armature provided with a cam follower, a drive shaft, a cam thereon with which said follower is constantly engaged under all operating conditions and means periodically permitting a relative slip about the axis of said shaft between said cam and follower so that the change in relative positions of the cam and follower may be periodically increased over that effected by said drive shaft.

6. In a magneto, a movable armature, driving means, an actuating cam for the armature free to turn relatively to said means, interengageable devices one on said cam and one on said means arranged by abutment to drive the former from the latter, and spacing means movable between said devices to vary the position of the cam on its driving means.

7. In a magneto, a movable armature, driving means, an actuating cam for the armature free to turn relatively to said means, interengageable devices one on said cam and one on said means arranged by abutment to drive the former from the latter, spacing means movable between said devices to vary the position of the cam on its driving means, and means to releasably hold the spacing means in an inactive position.

8. In a magneto, a movable armature, driving means, an actuating cam for the armature free to turn relatively to said means, interengageable devices one on said cam and one on said means arranged by abutment to drive the former from the latter, spacing means movable between said devices to vary the position of the cam on its driving means, means to move said spacing means toward said devices, and manually releasable means to hold said spacing means in an inactive position.

9. In a magneto, a movable armature, an actuating cam, and a cam follower therefor, a driving member with relation to which the cam is free to turn, a device on the cam and a device on said member to drive the cam from the latter by abutment, and means forcing said follower against the cam, the latter having a part so inclined to the direction of pressure of the follower that pressure of the latter on such part will move the cam ahead of its drive shaft and separate said devices, a second member axially movable relatively to said driving member and carrying a spacer for interposition between said devices when separated, means to move said members the one relatively to the other, and manually releasable means to hold the second member in inactive position.

10. In a magneto, a movable armature, an actuating cam, a cam follower therefor, a driving member with relation to which the cam is free to turn, a device on the cam and a device on said member to drive the cam from the latter by abutment, means forcing said follower against the cam, the latter having a part so inclined to the line of travel of the follower that pressure of the latter on such part will move the cam ahead of its drive shaft and separate said devices, a second member axially and angularly movable relatively to said driving member and carrying a spacer for optional interposition between said devices when separated, means to move said members axially, the one relatively to the other, means operable by relative angular movement of said members to release the latter for axial movement.

11. In a magneto, a movable armature, driving means, an actuating cam for the armature free to turn relatively to said means, interengageable devices one on said cam and

one on said means arranged by abutment to drive the former from the latter, and spacing means automatically movable between said devices to vary the position of the cam on its driving means.

12. In a megneto, a movable armature, driving means, an actuating cam for the armature free to turn relatively to said means, interengageable devices one on said cam and one on said means arranged by abutment to drive the former from the latter, and spacing means operable as the engine reaches a predetermined speed to move between said devices to vary the position of the cam on its driving means.

In testimony whereof I have affixed my signature.

PHELPS BROWN.

C. F. KETTERING.

ENGINE.

APPLICATION FILED APR. 1, 1918.

1,430,524. Patented Sept. 26, 1922.

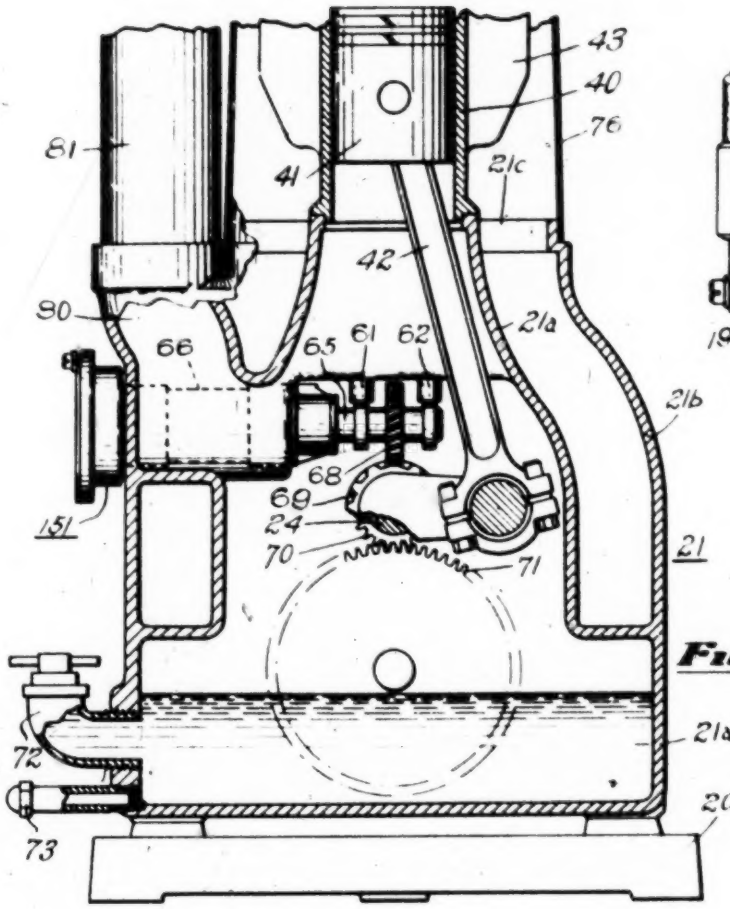

Fig. 1.

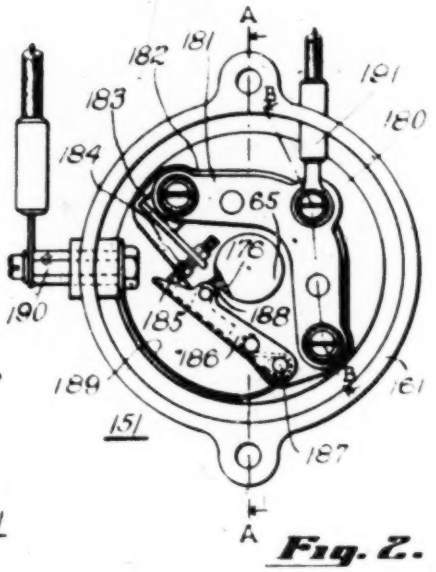

Fig. 2.

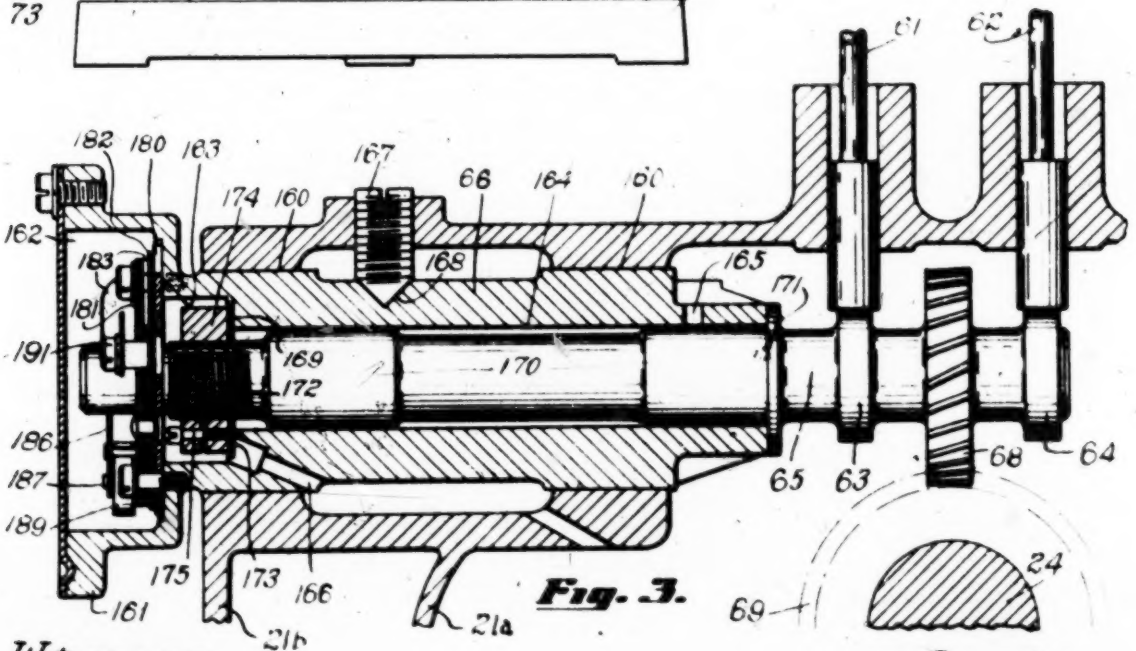

Fig. 3.

Witnesses
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Patented Sept. 26, 1922. 1,430,524

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DELCO-LIGHT COMPANY, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

ENGINE.

Application filed April 1, 1918. Serial No. 225,902.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Engines, of which the following is a full, clear, and exact description.

This invention relates to an internal-combustion engine and has for its principal object the provision of improvements in the construction thereof.

An object of the invention is to provide an ignition timer and cam shaft assembly which may be removed as a unit from the crank case of the engine while maintaining the crank case substantially intact.

More specifically, it is an object of the invention to provide the crank case with an opening adapted to receive a bearing member for the engine cam shaft, the opening being of such size as to permit the withdrawal of the bearing member and cam shaft, together with all operating parts carried thereby, to the exterior of the crank case without removing any substantial part of the crank case or gaining access to the interior thereof.

Other objects of the present invention will be apparent from the following description of a preferred embodiment thereof, reference being had to the accompanying drawings.

In the drawings:

Fig. 1 is a central longitudinal sectional view of an engine embodying the present invention, parts thereof being shown in elevation;

Fig. 2 is an end view of the cam shaft bearing member showing the ignition timer elements mounted thereon; and

Fig. 3 is a sectional view of a portion of the crank case showing the ignition timer and valve shaft assembly partly in section and partly in elevation, the bearing member and timer housing being a section on the line A—A of Fig. 2 and the timer mechanism within the timer housing being a section on the irregular line B—B of Fig. 2.

Referring to the drawings, 20 designates a base supporting a crank case casting 21. Casting 21 comprises the crank case proper 21^a, which includes a lubricant reservoir located at the bottom of the casting, and a chamber extending upwardly from the reservoir which provides a housing for the crank shaft, connecting rod, and other moving parts. The crank case casting 21 also includes a jacket 21^b surrounding the upper portion of the crank case, said jacket terminating with a circular flange 21^c substantially on the level with the upper end of the crank case 21^a, and cooperating with crank case 21^a to form an annular passage surrounding said crank case for a purpose to be described.

The crank case 21^a supports cylinder 40, in which is mounted for reciprocation a piston 41, which is connected by means of connecting rod 42 to crank shaft 24 journaled in the walls of the crank case. The engine is provided with the usual intake and exhaust passages, puppet valves therefor, and suitable valve gear for operating the valves, all operating in a manner well understood by those skilled in the art and for that reason not deemed necessary to be illustrated. The valve gear includes push rods 61 and 62 adapted to be actuated by cams 63 and 64 carried by the cam shaft 65 which is mounted for rotation in a sleeve bearing member 66 extending through an opening in the wall of the crank case casting. The cam shaft and its bearing member carry at their outer ends the ignition timer mechanism designated generally by the reference character 151. The cam shaft and timer mechanism are operated from the engine crank shaft by means of cooperating gears 68 and 69 mounted on the cam shaft and crank shaft respectively.

The engine herein illustrated is provided with a breather 81 which is connected at its upper end with the intake passage and at its lower end communicates with the crank case through passage 80. The breather is substantially the same as that which forms the subject matter of my Patent Number 1,380,974, dated June 7, 1921. Around the cylinder and its associated parts there is disposed a draft tube 76 which fits over the flange 21^c on the crank case jacket 21^b and which, with the cylinder 40, forms a continuation of the passage between the crank case 21^a and the crank case jacket 21^b. Suitable means may be provided for causing the circulation of cooling air through the passage about the cylinder and the crank case, and to more effectively cool the cylinder 40 it is provided with radiating fins 43.

Gear 71 mounted upon casting 21 cooperates with gear 70 carried by the crank shaft 24 for the purpose of throwing oil which is contained in the lower part of the crank case 21ª, to the various moving parts contained within the crank case. Oil may be introduced through pipe 72 and may be drained off through pipe 73.

The cam shaft and ignition timer assembly will next be described. Referring to Figs. 1 and 2, the crank case casting 21 is bored transversely at 160 to provide an opening for the reception of cam shaft bearing member 66, which is provided with finished surfaces adapted to engage with the corresponding finished surfaces of the bore 160 adjacent both ends thereof as shown. One end of the cam shaft bearing member 66 is flared outwardly to form a cup shaped extension or timer cup 161, concentric with the cam shaft which forms a chamber 162 for housing the ignition timer elements. The bearing member 66 is further provided with a recess 163 for a purpose to be described, and is bored out longitudinally at 164 to form a bearing for the cam shaft 65. Bearing member 66 is secured in position within the crank case and located with relation to the crank shaft, by means of set screw 167 which seats in socket 168 drilled in the bearing.

Cam shaft 65 is provided with journals 170, a shoulder 171 and with a threaded portion 172 which is engaged by lock nut 174 adapted to be locked in position by means of screw 175. Cam shaft 65 is located with respect to the bearing member 66 by means of shoulder 171, abutting one end of said bearing member and by means of nut 174 and washer 173, located in recess 163 and abutting shoulder 169 formed on the other end of said bearing member. Lubrication for the cam shaft bearing is provided for by means of passage 165 conducting lubricant, which is splashed up by means of the crank shaft 24 and the lubricating gear 71, around the cam shaft journals 170. Passage 166 conducts away the surplus lubricant which returns to the crank case.

The outer end of the cam shaft is flattened at 176 to provide the timer camming surface. Mounted within the chamber 162 and upon timer cup 161, is the timer base 180. Carried by the base 180 and insulated therefrom by the insulating plates 181 and 182, between which it is secured, is a conducting plate 183 terminating in a bracket which adjustably supports stationary timer contact 184. Cooperating with stationary contact 184 there is contact 185, mounted upon contact arm 186 which is pivotally mounted upon insulating plate 182 by means of pivot 187. Contact arm 186 carries a fiber cam follower 188, which cooperates with the timer cam surface at the end of cam shaft 65. A spring 189 serves to maintain the timer contacts in touching relation, except at such times as the cylindrical surface of the outer end of the cam shaft 65 engages with cam follower 188. Spring 189 serves also to conduct current from timer terminal 190 to contact arm 186. Timer terminals 190 and 191 may be connected in series with a battery and the primary winding of an ignition coil, not shown. It is evident that the closing of timer contacts will permit the current to build up in the primary winding of the ignition coil, and at the separation of the contacts will produce a sparking impulse in the secondary winding to give the necessary ignition spark at the spark plug of the engine.

It will be apparent from the foregoing description that there has been provided a cam shaft, which carries valve operating cams and the timer cam, and also a gear adapted to be driven by a gear on the crank shaft. By virtue of this construction there is but one driving connection between the crank shaft and the cam shaft and no geared connection between the cam shaft and the timer cam. The cam shaft gear, the valve operating cams and the timer cam may be accurately located with respect to each other, or may be formed integrally with the cam shaft in a very simple manner. It follows that the problem of locating the various cams with respect to the engine crank shaft has been solved in an extremely simple manner. It is also apparent, that there has been provided a bearing member for the cam shaft which serves as a housing for the ignition timer elements, and that said bearing member and parts carried thereby, including the cam shaft, may be removed in assembled relation as a unit from the crank case. This is possible because the diameter of the bore or opening 160 is made larger than the cam shaft gear 68 and cams carried by the cam shaft, so that these operating parts may clear the opening formed in the crank case.

The removal of the ignition timer and cam shaft assembly may be readily and quickly accomplished by simply loosening the set screw 167, raising the push rod 61 until it clears the gear 68 and then, by taking hold of the timer cup 161, withdrawing the entire assembly axially through the bore or opening 160, the gear 68 unmeshing with gear 69 during this movement. To reassemble, the operation is of course reversed except that it may be necessary, in addition to raising the push rod 61 until it clears the gear 68, to also raise the push rod 62 to clear the cam 64 as the latter is moved into place under the push

rod 62. In any event, it will be observed, the operating parts or means 63, 64, and 68 may be readily disengaged from the parts cooperating therewith, and the cam shaft and parts assembled thereon either withdrawn or inserted through the opening 160 while maintaining the crank case substantially intact. Where the expression "substantially intact" is used in the claims as applied to a crank case it should be clearly understood that this has reference to any suitable or desired construction of crank case, whether completely closed or only partially closed, in which the cam shaft and operating parts assembled thereon may be removed through an opening in the crank case without removing some substantial part of the crank case or first gaining access to the interior thereof for the purpose of adjusting, disengaging, or removing some interferring or cooperating part on the interior of the crank case.

While the present invention is herein shown and described as applied to the crank case of an internal-combustion engine, it should be understood that this is not to be considered as a limitation in any respect, since the invention is equally useful in any other device or apparatus requiring the removal of a shaft and the parts assembled thereon for inspection, repair or replacement.

While the form of mechanism herein shown and described constitutes a preferred embodiment of one form of the invention, it is to be understood that other forms might be adapted and various changes and alterations made in the shape, size, and proportion of the elements therein, without departing from the spirit and scope of the invention.

What I claim is as follows:

1. In a device of the kind described, the combination in an internal-combustion engine including a crank case, a crank shaft supported thereby, an operating valve, and an ignition device; of a cam shaft provided with a valve cam and an ignition timer cam; a bearing member supporting the cam shaft and provided with means for supporting ignition timer elements which include cooperating stationary and movable contacts adapted to be connected in an ignition circuit; a contact arm carrying the movable contact, mounted on the bearing member, and provided with a portion engaging the timer cam; gearing within the crank case between the cam shaft and crank shaft; and means provided on the crank case for removably supporting the cam shaft bearing member, said supporting means being constructed and arranged so as to permit the removal of the cam shaft and bearing member, and parts assembled thereon, to the exterior of the crank case, while maintaining the latter substantially intact.

2. In a device of the kind described, the combination in an internal-combustion engine including a crank case, a crank shaft supported thereby, an operating valve, and an ignition device; of a driving gear on the crank shaft; a cam shaft bearing member having a bearing within which a cam shaft may be supported for rotation, and having a cup-shaped extension on one end thereof; ignition timer elements mounted upon the cup-shaped extension including movable and stationary contact elements adapted to be connected in an ignition circuit; a cam shaft supported in said bearing, and provided with a valve cam and a timer cam adapted to cooperate with the movable contact element of the ignition timer, and having a gear adapted to cooperate with the driving gear of the crank shaft; and provisions formed upon the crank case for supporting the cam shaft bearing member with said gears in engagement within the crank case, said bearing member and said supporting provisions being constructed and arranged so that the bearing member and parts supported thereon may be removed in assembled relation from the crank case to the exterior thereof, while maintaining the crank case substantially intact.

3. In a device of the kind described, the combination in an internal-combustion engine having a crank case and a crank shaft; of an ignition circuit-controlling device including circuit breaking elements; a shaft provided with means for operating the engine valves and the circuit breaking elements; a common element for supporting the shaft and ignition circuit-controlling device upon the crank case; and gearing within the crank case for driving the second mentioned shaft from the crank shaft, the common element and second mentioned shaft being removable in assembled relation from the crank case to the exterior thereof, while maintaining the crank case substantially intact.

4. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means cooperating with said shaft and adapted to be actuated thereby, said cooperating means being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact.

5. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means cooperating with said shaft and adapted to be actuated thereby, said means including a cam on said shaft and being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact.

6. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means cooperating with said shaft and adapted to be actuated thereby, said means including a cam on said shaft within the crank case and being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact.

7. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means cooperating with said shaft and adapted to be actuated thereby, said means including valve and timer actuating cams driven by said shaft, and said means being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact.

8. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means including timer mechanism cooperating with said shaft and adapted to be actuated thereby, said cooperating means being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact.

9. In a device of the character described, in combination, a crank case provided with an opening in the wall thereof; a crank shaft journaled in the crank case; a shaft extending through said opening and supported for rotation therein; a driving connection between said shaft and the crank shaft including a gear mounted on said shaft within the crank case of a size adapted to pass through said opening; and means cooperating with said shaft and adapted to be actuated thereby, said cooperating means being constructed and arranged to permit the removal of said shaft and parts assembled thereon through said opening while maintaining the crank case substantially intact, and said means including ignition timer-mechanism adapted to be actuated by the outer end of said shaft.

10. An engine of the character described comprising in combination, a casing provided with an opening in the wall thereof; a crank shaft; a second shaft; means for journaling said shafts for rotation in the casing, said means including a bearing member for one of said shafts in said opening; a driving connection between said shafts including a gear on said last-mentioned shaft within the casing of a size adapted to pass through said opening; and means on said last-mentioned shaft adapted to cooperate with other movable engine parts, said means and said cooperating engine parts being constructed and arranged to permit endwise removal of said last-mentioned shaft with said gear and said bearing member assembled thereon through said opening while maintaining the casing substantially intact.

In testimony whereof I affix my signature.

CHARLES F. KETTERING.

Witnesses:
WARREN SCHMIEDING,
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P-173

Mar. 6, 1923. 1,447,245

W. W. GORE

INTERNAL COMBUSTION ENGINE

Filed Sept. 25, 1918 2 sheets-sheet 1

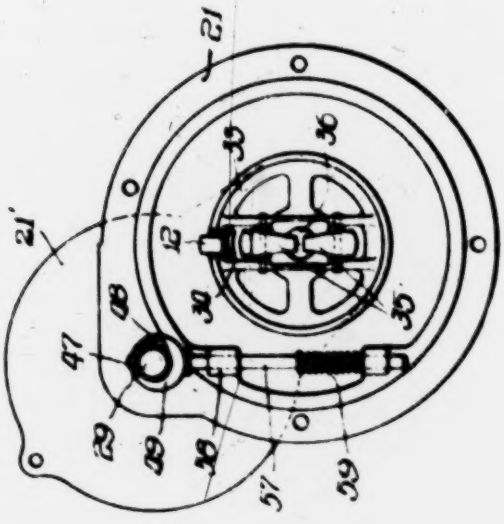

Fig 3

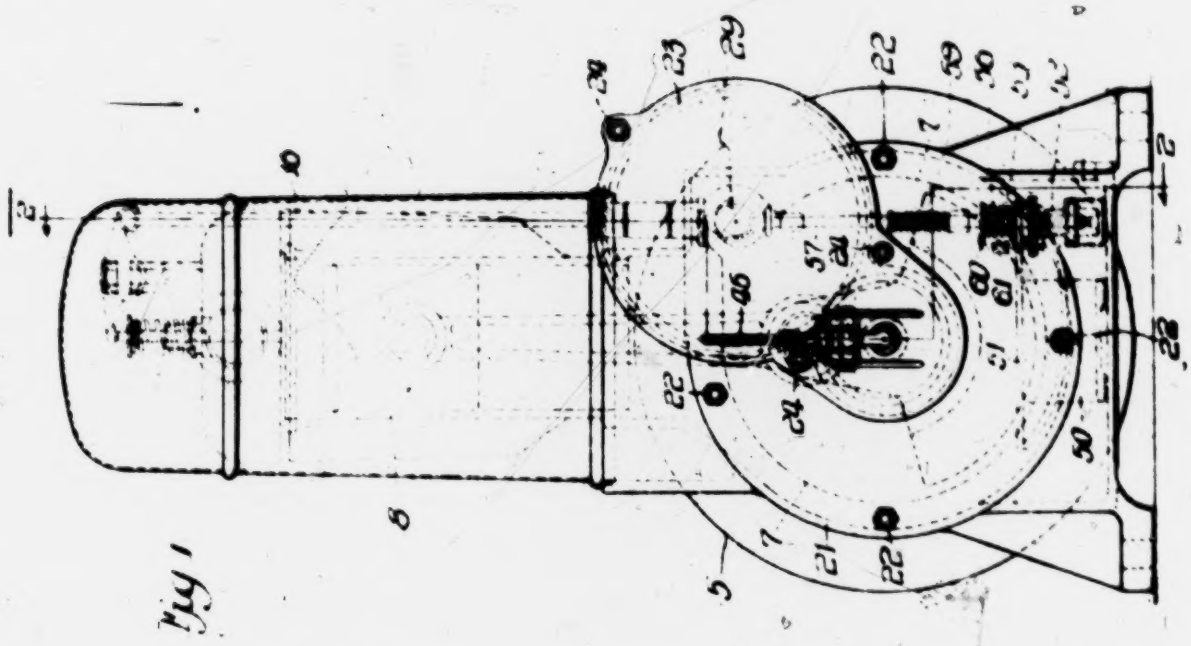

Fig 1

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Mar. 6, 1923. 1,447,245

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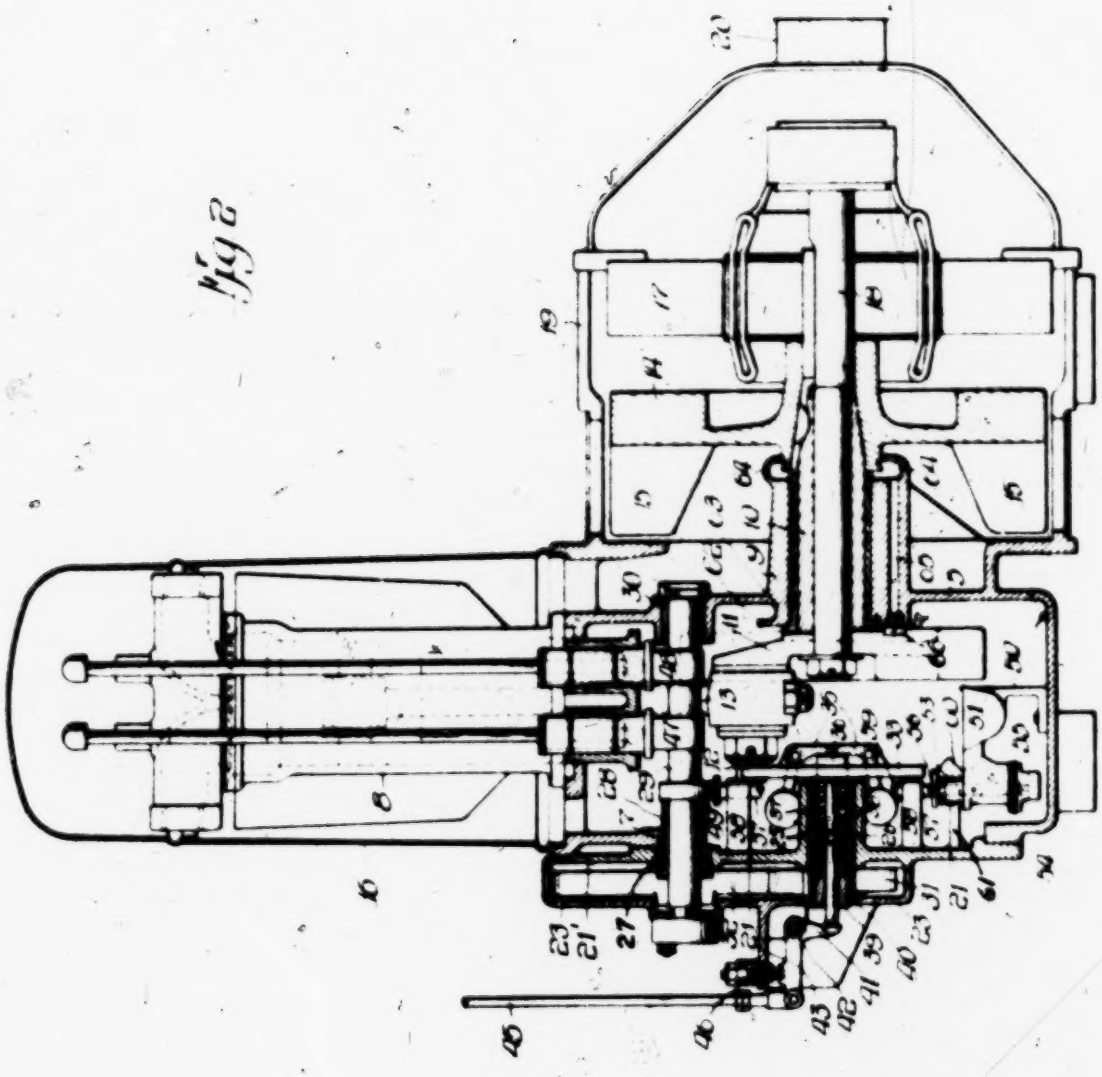
INTERNAL COMBUSTION ENGINE

Filed Sept. [illegible], 1918 [illegible] sheets sheet

Fig 2



Witness
[illegible] Burkhardt

Inventor
Warren W. Gore,
By Pond & Wilson.
Attys.

Patented Mar. 6, 1923. 1,447,245

UNITED STATES PATENT OFFICE.

WARREN W. GORE, OF MADISON, WISCONSIN, ASSIGNOR TO FULLER & JOHNSON MFG. CO., OF MADISON, WISCONSIN, A CORPORATION OF WISCONSIN.

INTERNAL-COMBUSTION ENGINE.

Application filed September 25, 1918. Serial No. 255,560

To all whom it may concern:

Be it known that I, WARREN W. GORE, a citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines, and has reference more particularly, although not exclusively, to single-cylinder stationary engines of the upright type such as are extensively employed as a power unit in domestic use for pumping water, generating electric current, etc.

Since gas engines of this character are generally owned and used by persons not particularly skilled in their construction and operation, it is desirable to make them not only as simple, durable and completely automatic as possible, but also to make them easy of access, especially as regards the crank-chamber and its contained parts, for inspection, cleaning, adjustment, and repairs when necessary, with a minimum of labor and trouble in the disassembling and reassembling of parts; and one of the objects of the present invention is to provide an internal combustion engine possessing in a superior degree the advantages stated. More specifically, one object of the invention is to provide a gas engine of the enclosed crank-case type, wherein the crank-case is provided with a removable side or cover plate carrying the cam-shaft and the driving mechanism of the latter, said driving mechanism being automatically engaged with and disengaged from the crank-pin of the engine shaft when the detachable side of the crank-case is applied and removed. In the most complete and approved form of the invention herein illustrated this detachable side may also carry the governing mechanism of the engine throttle. Another object of the invention is to provide in the crank-case an improved oil pan through which the lower end of the connecting rod sweeps to distribute oil to the cylinder walls on the splash principle, with a pump also located in the crank-case to maintain a supply of oil to said pan, and a pump-driving mechanism carried by said removable side of the crank-case and automatically registering with the oil-pump plunger when the removable side is applied to the crank-case.

Other objects and advantages secured by the invention will be apparent to those skilled in the art from the following detailed description, taken in connection with the accompanying drawings wherein I have illustrated one practical embodiment of the invention, and in which—

Fig. 1 is a side elevation of the engine;

Fig. 2 is a vertical section, substantially on the offset line 2—2 of Fig. 1;

Fig. 3 is a detail view from the inner side of the detachable side plate or cover of the crank-case and parts carried thereby.

Referring to the drawings, 5 designates as an entirety the body of the crank-case formed with supporting feet 6, and having a large substantially circular opening 7 at one side thereof. Superposed on the crank-case is the engine cylinder 8, equipped with the usual piston, intake and exhaust valves, and ignition mechanism, with which parts my present invention is not concerned. On the opposite side of the crank-case from the opening 7 is a main bearing 9 for the engine shaft 10, on the inner end of which shaft is the usual balanced crank-arm 11 carrying crank-pin 12 on which is mounted the lower end of the piston-rod 13. Keyed on the crank-shaft is a fly-wheel 14 carrying fan-blades 16 by which air is drawn down through a hood 16 surrounding the cylinder to cool the latter. Beyond the fly-wheel I have indicated in Fig. 2 an electric generator 17, the armature shaft 18 of which is mounted within the hollow engine shaft 10. Secured to one side of the crank case and surrounding the fly-wheel and generator is a casing 19 formed at its outer end with a bearing 20 to receive a pulley-shaft extension of the engine shaft for power transmitting purposes, when the generator is not used.

21 designates a substantially circular plate that forms a cover or closure for the side opening 7 of the crank-case, being detachably secured to the rim of the opening by four machine screws 22 (Fig. 1). This plate 21 is formed with an integral eccentric extension 21′ that, with a portion of the plate 21, constitutes the inner wall of a gear case, the outer wall of which is formed by a flanged plate 23 secured to the inner wall by three

machine screws 24. On and centrally of the main cover-plate 21 is an integral inwardly extending boss 25 that forms a bearing for a hollow shaft 26, and in an opening 27 of said plate 21 is fitted a bearing sleeve 28 for the cam shaft 29, the other end of said cam shaft being journaled in a bearing sleeve 30 mounted in the opposite wall of the crank-case. Fast on the shafts 26 and 29 are the usual two-to-one gears 31 and 32. Fast on the inner end of shaft 26 is a skeleton disk 33 formed with a peripheral notch 34 (Fig. 3) that fits over the squared outer end of the crank-pin 12, being engaged with and disengaged from said crank-pin under a simple lateral movement of said disk.

Pivoted on the disk 33 are the governor elbow levers 35, the inner ends of which abut against a sliding rod 36 mounted in the hollow shaft 26 and pressed against the thrust of the governor levers by a spring 37. The inner end of rod 36 presses, through a ball thrust-bearing 38, against an alined rod 39 slidably mounted in a bearing sleeve 40 secured in the outer end of shaft 26. The outer end of rod 39 abuts against the depending arm 41 of an elbow lever pivoted at 42 to a bracket 43 on the outer side of the gear cover plate 23, and to the horizontal arm 44 of said elbow lever is pivoted an upwardly extending rod 45 that is connected to the throttle of the carbureter (not shown). An adjustable spring 46 mounted on bracket 43 bears downwardly on the horizontal arm 44 of the elbow lever and tends to open the throttle in opposition to the closing tendency of ball governor.

The cam shaft 29 carries the two cams 47 and 48 (Fig. 2) for operating the intake and exhaust valves of the cylinder, as usual in this type of overhead-valve engine. The cam shaft also carries an eccentric 49 for effecting the discharge stroke of an oil pump hereinafter described.

Secured to the bottom wall of the crank-case is a bracket 50 that supports an oil-pan 51 through which the lower end of the piston-rod sweeps at each revolution of the crank-shaft. This oil-pan is supplied with oil from the bottom of the crank-case by means of a pump comprising a cylinder 52, vertical plunger 53 and intake and discharge valves 54 and 55. The plunger is raised on its suction stroke by a spring 56, and is depressed on its working or discharge stroke by a rod 57 that is guided in lugs 58 on the inner face of the cover plate 21; the upper end of said rod being held in engagement with the eccentric 49 by a spring 59. On one side of the pump cylinder is pivoted a latch 60, the laterally bent upper end of which is adapted to engage over the upper end of the pump plunger to hold the same down against spring 56 when the detachable cover is being applied to the crank-case so as to bring the lower end of rod 57 into working engagement with the upper end of the plunger. While this engagement is being effected, the latch is kicked off by a lug 61 projecting inwardly from the inner face of cover plate 21.

My invention also includes an improved construction for effecting the lubrication of the main shaft bearing and the return to the crank-case of the oil that works through the main bearing. It will be observed that the main bearing 9 projects slightly inwardly of the side wall of the crank-case, and is formed on its upper side with a channel or pocket 62 to catch the oil splash, and with a duct 63 leading from said channel or pocket to the bearing. At the outer end of the main bearing is an annular channel 64 that catches the oil working through the bearing, and from the lowest point of channel 64 is a drain duct 65 drilled through a rib under the main bearing and leading into the crank-case, the inner end of said duct being provided with a check-valve 66. The crank-case is provided with the usual breather, which allows part of the air in the crank-case to discharge on the down stroke of the piston. On the up stroke of the piston a partial vacuum is formed in the crank-case which tends to create a suction through the bearings and also through the drain duct 65, thus returning to the crank-case the oil that has worked through the bearing into the oil-collecting channel 64. The check-valve 66 prevents the oil from being blown outwardly through the drain duct 65 on the down stroke of the piston. In this way a continuous circulation of oil through the main shaft bearing is maintained.

The principal advantage of the described construction resides in the facility and ease with which access may be obtained to the interior of the crank-case for inspection, cleaning, adjustment, or repairs, or any other purpose without partially dismantling or disassembling the various working parts of the engine. All that is necessary is to disconnect the governor-rod 45 from the throttle, remove the four machine screws 22, and withdraw the cover plate and gear casing with the parts carried thereby, as a unit, from the open side of the crank-case. This automatically disconnects the driving disk 33 of the cam-shaft and governor from the squared end of the crank-pin by a mere sliding movement. In reassembling it is impossible to disarrange the proper timing of the parts, since the registration of the notch 34 with the end of the crank-pin 12 insures the correct position of the valve cams.

It is believed that the foregoing will make clear to those skilled in the art the novel structural features, mode of operation, and

advantages of the present invention. Without limiting the invention to the specific details shown and described for purposes of illustration,—

I claim—

1. In an internal combustion engine, the combination of a crank-chamber having an engine-shaft bearing in one side wall thereof and a relatively large opening in the opposite side wall, an engine shaft mounted in said bearing, a crank-arm on said shaft, a crank-pin on said arm having a free end, a detachable cover-plate for said opening, and a cam-shaft and cam-shaft driving mechanism mounted on and removable as a unit with said cover-plate, said cam-shaft driving mechanism being automatically engaged with and disengaged from the free end of said crank-pin as said cover-plate is applied to and removed from said opening.

2. In an internal combustion engine, the combination of a crank-chamber having an engine-shaft bearing in one side wall thereof and a relatively large opening in the opposite side wall, an engine shaft mounted in said bearing, a crank-arm on said shaft, a crank-pin on said arm having a free end, a detachable cover-plate for said opening, and a cam-shaft and cam-shaft driving mechanism mounted on and removable as a unit with said cover-plate, said cam-shaft driving mechanism including a peripherally notched rotatable element that is slidable into and out of driven engagement with the free end of said crank-pin as said cover-plate is applied to and removed from said opening.

3. In an internal combustion engine, the combination of a crank-chamber having an engine-shaft bearing in one side wall thereof and a relatively large opening in the opposite side wall, an engine shaft mounted in said bearing, a crank-arm on said shaft, a crank-pin on said arm having a free end, a detachable cover-plate for said opening, a cam-shaft and cam-shaft driving mechanism mounted on and removable as a unit with said cover-plate, said cam-shaft driving mechanism being automatically engaged with and disengaged from the free end of said crank-pin as said cover-plate is applied to and removed from said opening, and a governor mechanism mounted in said cover-plate and actuated by an element of said cam-shaft driving mechanism.

4. In an internal combustion engine, the combination of a crank-chamber having an engine-shaft bearing in one side wall thereof and a relatively large opening in the opposite side wall, an engine shaft mounted in said bearing, a crank-arm on said shaft, a crank-pin on said arm having a free end, a detachable cover-plate for said opening, a cam-shaft and cam-shaft driving mechanism mounted on and removable as a unit with said cover-plate, said cam-shaft driving mechanism including a peripherally notched rotatable member journaled in said cover-plate and slidable into and out of driven engagement with the free end of said crank-pin as said cover-plate is applied to and removed from said opening, and a governor mechanism mounted in said cover-plate and actuated by said rotatable member of said cam-shaft driving mechanism.

5. In an internal combustion engine, the combination of a crank-chamber having an engine-shaft bearing in one side wall thereof and a relatively large opening in the opposite side wall, an engine shaft mounted in said bearing, a crank-arm on said shaft, a crank-pin on said arm having a free end, a detachable cover-plate for said opening, a cam-shaft journaled in said cover-plate, a gear-shaft also journaled in said cover-plate, co-operating gears on the outer ends of said shafts respectively, a gear-case attached to the outer side of said cover-plate, and a disk on the inner end of said gear-shaft having an opening to receive the free end of said crank-pin under a relative sliding movement as said cover-plate is applied to said opening of the crank-chamber, said cover-plate, shafts, gears, gear-case and disk being removable as a unit from said crank-chamber.

6. In an internal combustion engine, the combination of a crank-chamber having an opening in one of its side walls, an oil-pan mounted in said crank-chamber beneath and in the path of travel of the lower end of the piston-rod, a pump in said crank-chamber for supplying oil to said oil-pan, a detachable cover-plate for said opening, and operating mechanism for said pump mounted on the inner side of said cover plate and removable as a unit with the latter.

7. In an internal combustion engine, the combination of a crank-chamber having an opening in one of its side walls, an oil-pan mounted in said crank-chamber beneath and in the path of travel of the lower end of the piston-rod, a pump in said crank-chamber for supplying oil to said oil-pan, a detachable cover-plate for said opening, and operating mechanism for said pump, including a shaft, an eccentric on said shaft, and a rod driven by said eccentric and actuating the plunger of said pump, all mounted on, and removable as a unit with, said cover-plate.

8. In an internal combustion engine, the combination of a crank-chamber having an opening in one of its side walls, an oil-pan mounted in said crank-chamber beneath and in the path of travel of the lower end of the piston-rod, a pump in said crank-chamber for supplying oil to said oil-pan, a spring to actuate the plunger of said

pump on its suction stroke, a detachable cover-plate for said opening, operating mechanism, including a reciprocating rod engaging the outer end of said pump plunger, mounted on and removable as a unit with said cover-plate, a latch engaging said plunger to hold the same retracted and permit engagement of said plunger by said rod as said cover-plate is applied to said opening, and means carried by said cover-plate for disengaging said latch from said plunger after said rod has been engaged with the latter.

WARREN W. GORE.

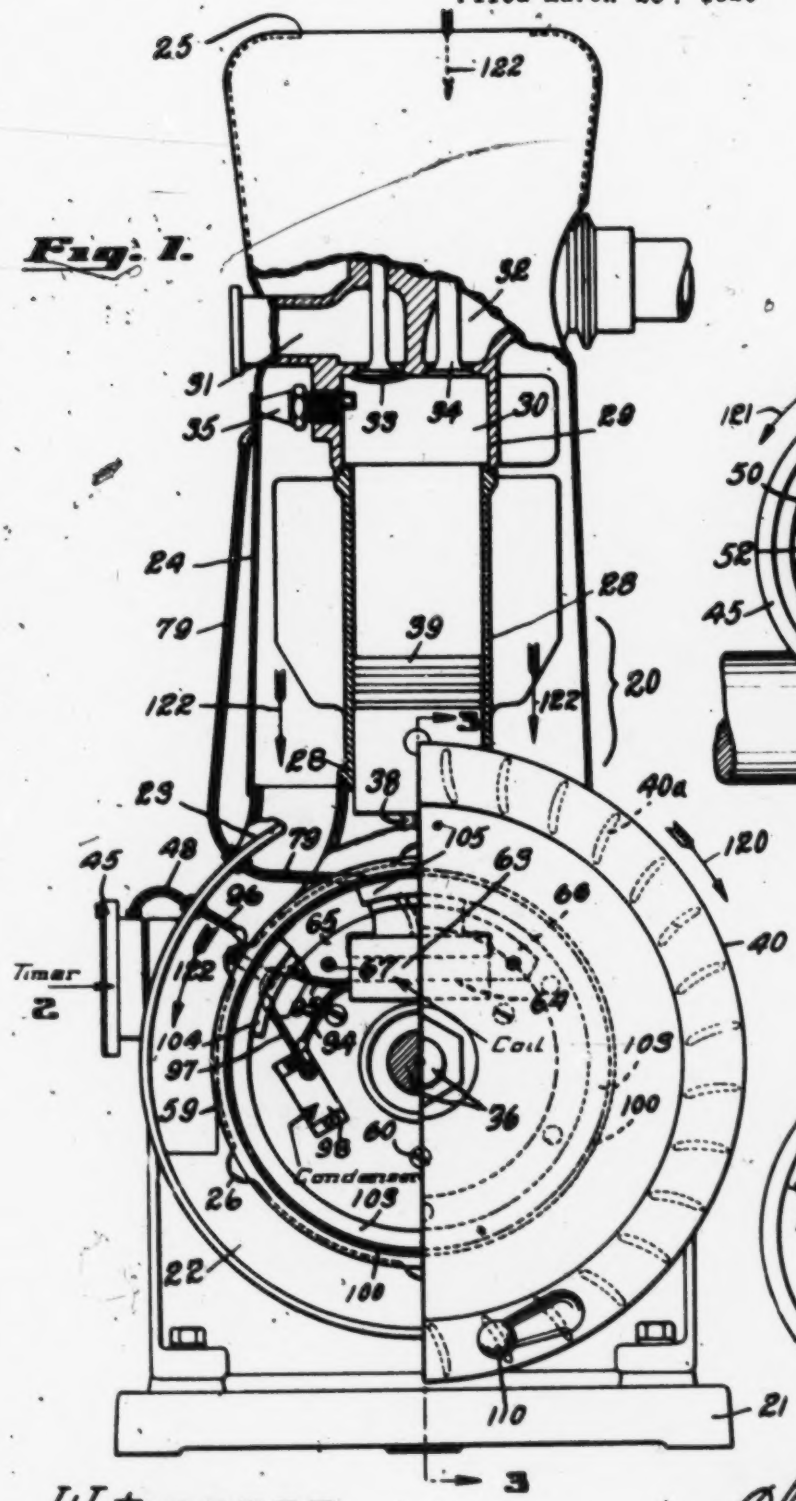
Aug. 7, 1923. 1,463,958

C. F. KETTERING

MAGNETO IGNITION SYSTEM

Filed March 25, 1920 2 Sheets-Sheet 1

Fig. 1.



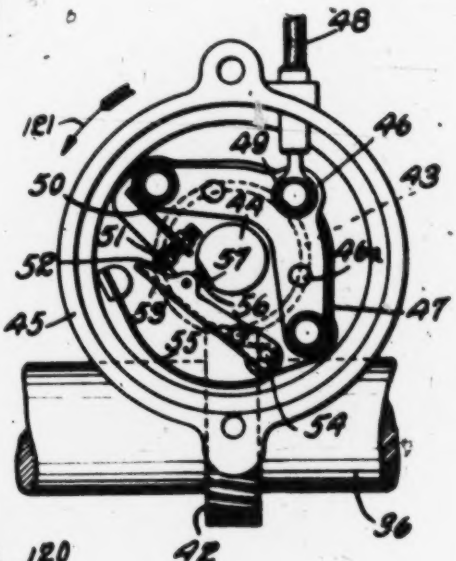


Fig. 2.

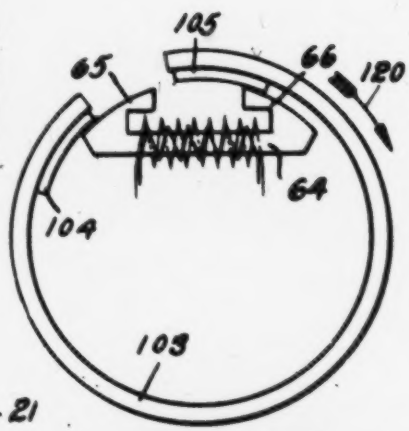


Fig. 5.

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Aug. 7, 1923. 1,463,958

C. F. KETTERING

MAGNETO IGNITION SYSTEM

Filed March 25, 1920 2 Sheets-Sheet 2

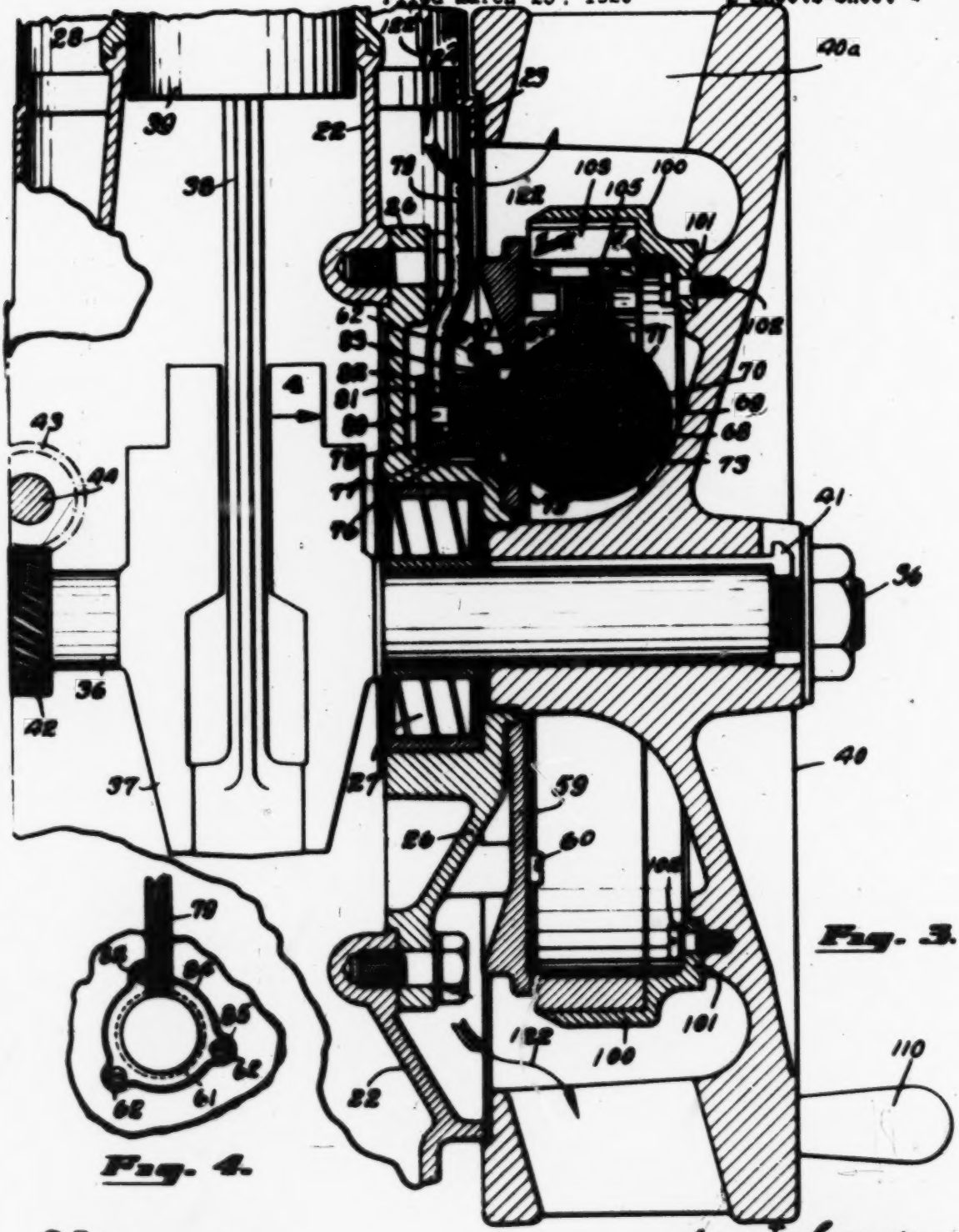

Fig. 3.

Fig. 4.

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Patented Aug. 7, 1923. 1,463,958

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR TO DELCO-LIGHT COMPANY, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

MAGNETO IGNITION SYSTEM.

Application filed March 25, 1920. Serial No. 368,789.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States of America, residing at Dayton, county of Montgomery, and State of Ohio, have invented certain new and useful Improvements in Magneto Ignition Systems, of which the following is a full, clear, and exact description.

This invention relates to ignition systems for internal-combustion engines, and particularly to systems including a magneto having a rotatable part mounted upon the engine flywheel. Such a magneto is generally termed a "flywheel magneto"

It is an object of the invention to provide for the mounting of the rotatable magneto part upon the flywheel of an air-cooled engine wherein the flywheel is constructed to operate as a fan to cool the engine, the manner of mounting being such as not to interfere with the function of the flywheel as a fan. In this connection it is a further object to provide a housing for the magneto in order to protect it from particles of dirt or dust, such as might pass around the engine during the operation of the engine cooling system.

As a means of carrying out the foregoing objects, the flywheel and the engine frame have cooperating provisions which form the magneto housing.

A further object is to provide a separate location for the magneto timer which shall be accessible without requiring the removal of the flywheel.

It is a still further object of the present invention to provide a simple means for connecting the secondary winding of the magneto to the conductor leading to the spark plug.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawing:

Fig. 1 is an elevation partly in section taken on the flywheel end of an internal-combustion engine, part of the flywheel being broken away showing the electrical connections between the different parts of the ignition system;

Fig. 2 is a front elevation of the timer shown in Fig. 1, looking in the direction of the arrow 2;

Fig. 3 is a fragmentary sectional view taken on line 3—3 of Fig. 1;

Fig. 4 is a view of the high tension terminal shown in Fig. 3, looking in the direction of the arrow 4; and

Fig. 5 is an elevational view, looking in the direction of Fig. 1, of the armature and magneto of the flywheel magneto, the magnet being shown in the position when the primary magneto circuit is interrupted to induce a sparking impulse.

Referring to the drawings, an internal combustion engine 20 includes a base 21 supporting a crank case 22, having an outer jacket 23 to provide an air space around crank case 22 for cooling purposes. Jacket 23 supports a draft tube 24 open at the upper end at 25. Crank case 22 is provided with a removable end cover 26 carrying a crank shaft bearing 27. Crank case 22 supports cylinder 28 carrying cylinder head 29 provided with explosion chamber 30. Chamber 30 is provided with intake passage 31 and exhaust passage 32 controlled by valves 33 and 34, respectively. Spark plug 35 projects into chamber 30.

A crank shaft 36 which is journalled within bearings, one of which is shown at 27, carries a crank 37. A connecting rod 38 connects the crank 37 with the piston 39. Crank shaft 36 carries a flywheel 40 which is keyed thereto by key 41. A gear 42 is provided on the crank shaft 36 which cooperates with a gear 43 carried by the timer shaft 44.

One end of timer shaft 44 rotates within a timer casting 45 projecting outwardly from the internal-combustion engine. A plate 46 is secured to the timer casting 45 by rivets 46ª and insulated from the casting by insulation strip 47. A conductor 48 is connected to plate 46 at terminal 49. A contact arm 50 which projects from the plate 46 carries an adjustable contact 51 which cooperates with a contact 52. Contact 52 is carried by an arm 53 which is pivotally mounted on stud 54 mounted on the casting 45. A spring

55 which is connected to the arm 53 normally tends to hold contacts 51 and 52 in contact. A block 56 provided on the arm 53 cooperates with cam shaft 44, said shaft having a flat portion 57 forming a cam cooperating with the block 56 intermittently to open contacts 51 and 52.

A non-magnetic bracket or plate 59 is secured to the end cover 26 by screws 60. Plate 59 is provided with an aperture 61 surrounded by an annular boss 62. A coil 63 is provided with an armature core 64 having armature heads 65 and 66, said heads being secured to the plate 59 by screws 67. A primary winding 68 is wound around core 64 and insulated therefrom by insulating material 69. Secondary winding 70 is wound around the primary winding 68 and insulated therefrom by insulating material 71. Insulating material 73 encircles the coil 63 and is provided with an opening 74 through which a hollow rivet 75 projects. A conically shaped non-conducting block 76 is riveted to the insulation 73 by the rivet 75 and is provided with a recess 77. A non-conducting plug 78 has an internally tapered surface which forms a seat for the block 76. A conductor 79 having a clip 80 attached thereto is inserted within a hole in the plug 78 and is held in place by a screw 81. One end of the winding 70 projects through the hollow rivet 75 into the recess 77 and is in contact with a spring 82. Spring 82 bears against screw 81. A flanged portion 83 on the plug 78 fits within the aperture 61 of the plate 59 and is secured therein by ring 84 which is held by screws 85 against the boss 62 of the plate 59.

Conductor 79 passes through crank case 22 and jacket 23 and is connected with spark plug 35. The other end of the secondary 70 is grounded on the primary 68 having one end grounded by means of wire 94 on the plate 59. Wire 95 connects the other end of the primary 68 with a terminal 96 which is mounted on plate 59 but insulated therefrom. Wire 48 connects terminal 96 with the timer.

Wire 97 connects terminal 96 with condenser 98 which is grounded upon plate 59.

A non-magnetic ring 100 having a flange 101 is secured to flywheel 40 by screws 102, and carries a permanent magnet 103 provided with pole shoes 104 and 105.

The engine is started manually by rotating by means of a handle 110 the flywheel 40 in the direction of arrow 120. Some time during the compression stroke of the engine the permanent magnet 103 will be in a position such that the armature head 65 will just bridge the gap between poles 104 and 105, short circuiting the flux of the magnet 103 from the armature core 64. Just prior to the proper firing time, the pole 105 will be leaving the head 65 and overlapping head 66, and the pole 104 will be overlapping the head 65. At this time there is a sudden inrush of flux from the magnet 103 across the armature core 64 causing the building up of current in the primary coil 68. By the time the magnet 103 is in the position shown in Fig. 5, the coil 68 will have built up to the maximum. This is the proper instant for firing, and the flat portion 57 on shaft 44 is arranged at this instant to cooperate with arm 53 to separate contacts 51 and 52 to interrupt the primary circuit. The direction of rotation of cam shaft 44 is indicated by arrow 121.

The interruption of the primary circuit will cause a sparking impulse to be induced in the secondary winding 70 thereby causing a spark to jump at the spark plug 35.

This particular construction and operation of the magneto generating elements is not of itself my invention but is described and claimed in the patent to R. A. Oglesby No. 1,279,750, issued September 24, 1918.

During each engine cycle there will be two revolutions of the flywheel hence there will be two abrupt reductions of magnetic flux in the armature core 64 during each engine cycle. By providing that the cam shaft 44 operates at one half engine speed there will be but one interruption of the primary circuit during each engine cycle to provide for the induction of a sparking impulse in the secondary. For a two cycle internal-combustion engine the cam shaft 44 may be operated at engine speed.

The periphery of the flywheel 40 is provided with spaced blades 40ª which during the operation of the engine create a draft causing the circulation of air about the cylinder 28 and between the crank case 22 and the jacket 23 and out through the flywheel, this current being indicated by the arrows 122 in Figs. 1 and 3. Referring to Fig. 3 it will be noted that the plate 59 and the ring 100 cooperate together to form an enclosure or housing for the magneto elements in such a manner as not to interfere with the function of the flywheel 40 as a fan. Ring 100 serves to direct air currents to the fan blades 40ª. This housing protects the magneto elements from particles of dirt and moisture which may be drawn through the flywheel during the cooling of the engine. The ring 100 also protects the magneto elements from anything which may happen to be dropped down through the spaces between the flywheel fan blades 40ª when the engine is stationary.

Instead of locating the magneto timer within the housing for the magneto generating elements, the timer is located outside of the flywheel and in a position which is readily accessible for purposes of adjustment or making repairs. This location of the timer is much more advantageous than

where the timer is located adjacent the magneto generating elements and within the flywheel structure. In the present invention the timer is accessible without removing the flywheel, whereas in the usual construction it is necessary to remove the flywheel to get at the timer.

It is apparent from the foregoing description that the construction and arrangement of the magneto elements is conducive to simplicity of manufacture. The flywheel together with the ring 100 supporting the permanent magnet 103 forms one unit, which is easily assembled upon the crank shaft 36, and the plate 59 or support carrying the magneto armature and windings and the terminals leading to the timer and spark plug forms another unit which may be easily attached to the crank case cover 26.

While the form of mechanism herein shown and described constitutes a preferred embodiment of one form of the invention, it is to be understood that other forms might be adopted and various changes and alterations made in the shape, size and proportion of the elements therein without departing from the spirit and scope of the invention.

What I claim is as follows:

1. In a device of the kind described, the combination with an engine comprising a flywheel cooling fan; of means carried by the engine frame and flywheel fan adapted to cooperate to form a housing within the flywheel fan; and a magneto-generator having stator and rotor elements carried within said housing by the engine frame and flywheel fan respectively.

2. In a device of the kind described, the combination with an internal combustion engine comprising a flywheel fan; of a magneto-generator including a stator and a rotor; a housing mounted on the flywheel and adjacent the engine frame, said rotor being carried by the flywheel within the housing and a support for the stator mounted on the engine frame adjacent the flywheel, said housing and support cooperating together to provide an enclosure for the magneto generator while permitting the passage of air through the fan.

3. In a magneto ignition system, the combination with an internal combustion engine having air cooling provisions including a jacket providing an air passage opening out adjacent one end of the engine frame, and a flywheel provided with peripherally arranged blades and located adjacent said jacket opening; of a magneto generator including a stationary armature and a movable magnet; a circular plate supported by the engine frame adjacent said jacket opening and providing an annular air passage communicating with the fan blades, said plate supporting the magneto armature; and a ring mounted upon the flywheel for supporting the magnet and extending adjacent to the plate to cooperate therewith to provide a magneto housing, said ring serving also to direct air currents to the fan blades.

4. In a magneto ignition system, the combination with an internal combustion engine having air cooling provisions including a jacket providing an air passage having a circular opening adjacent one end of the engine frame, and a flywheel provided with peripherally arranged blades and located closely adjacent to said circular jacket opening; of a magneto-generator including a stationary armature and a movable magnet; means for supporting the magnet by the flywheel; an armature support carried by the engine frame adjacent said jacket opening; and a high tension conductor connected with the armature and detachably secured to said armature support and extending within said jacket opening and thence out through said jacket.

5. In a magneto-ignition system, the combination with an internal combustion engine having a cup-shaped flywheel fan located adjacent one end of the engine frame; of a magneto-generator including a stationary armature and a movable magnet; means for supporting the magnet within the flywheel fan; a plate supported by but spaced from the engine frame and permitting the circulation of air therebetween, said plate supporting the magneto armature within the flywheel fan, and provided with an aperture; and a high tension conductor extending between the plate and engine frame and having a connection with the armature through said aperture.

6. In a magneto ignition system, the combination with an internal combustion engine having a flywheel fan located adjacent one end of the engine frame; of a magneto-generator including a stationary armature and a movable magnet; means for supporting the magnet upon the flywheel fan adjacent the engine frame; a plate supported by but spaced from the engine frame and permitting the circulation of air therebetween, said plate supporting the magneto armature adjacent said magnet, and provided with an aperture; and a high tension conductor extending between the plate and engine frame and having a connection with the armature through said aperture.

7. In a magneto ignition system, the combination with an internal combustion engine having a flywheel located adjacent one end of the engine frame; of a magneto-generator including a stator and a rotor; means for supporting the rotor upon the flywheel adjacent the engine frame; a plate supported by but spaced from the engine frame and supporting the stator adjacent said magnet, and provided with an aperture; and a high

tension conductor extending between the plate and engine frame and having a connection with the armature through said aperture, said connection including a nonconducting plug for said aperture attached to said conductor and provided with a recess enclosing a conductor, and including a block projecting into said recess and provided with a conductor attached to said armature and contacting with said plug conductor.

8. In a magneto ignition system, the combination with an internal combustion engine having a flywheel located adjacent one end of the engine frame; of a magneto-generator including a stator and a rotor; means for supporting the rotor upon the flywheel adjacent the engine frame; a plate supported by but spaced from the engine frame and supporting the stator adjacent said magnet, and provided with an aperture; and a high tension conductor extending between the plate and engine frame and having a connection with the armature through said aperture, said connection including a nonconducting recessed plug for said aperture attached to said conductor by means of a fastening having a head located within said recess, and including a block attached to said armature and carrying a spring electrically connected with said armature and adapted to cooperate with said fastening head; and means for detachably securing said plug upon said plate with the block extending into the plug recess.

9. In a device of the kind described, in combination, an engine having a crank case provided with a removable end wall; a flywheel cooling fan for the engine supported for rotation adjacent said removable end wall; means carried by said removable end wall and flywheel fan adapted to cooperate to form a housing within the flywheel fan; and a generator having stator and rotor elements carried within said housing by the removable end wall and flywheel fan respectively.

In testimony whereof I affix my signature.

CHARLES F. KETTERING.

Witnesses:
MILDRED PEARE,
MARY LAYTON.

Aug. 21, 1923. 1,465,644

C. F. KETTERING ET AL

IGNITION APPARATUS

Original Filed Oct. 4, 1915

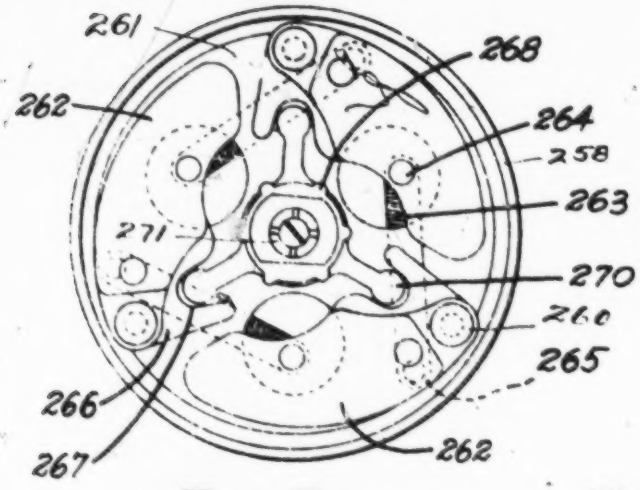

Fig. 2.

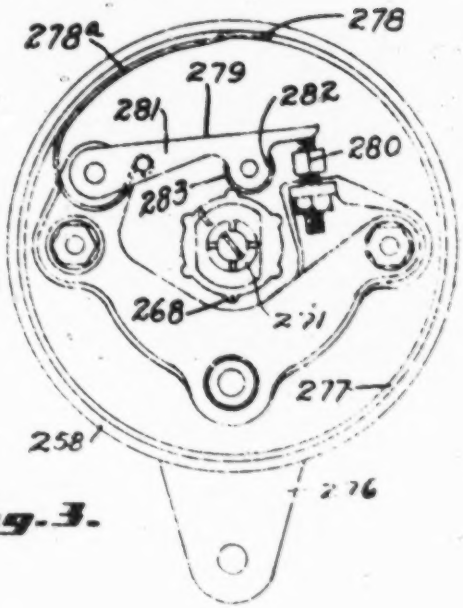

Fig. 3.

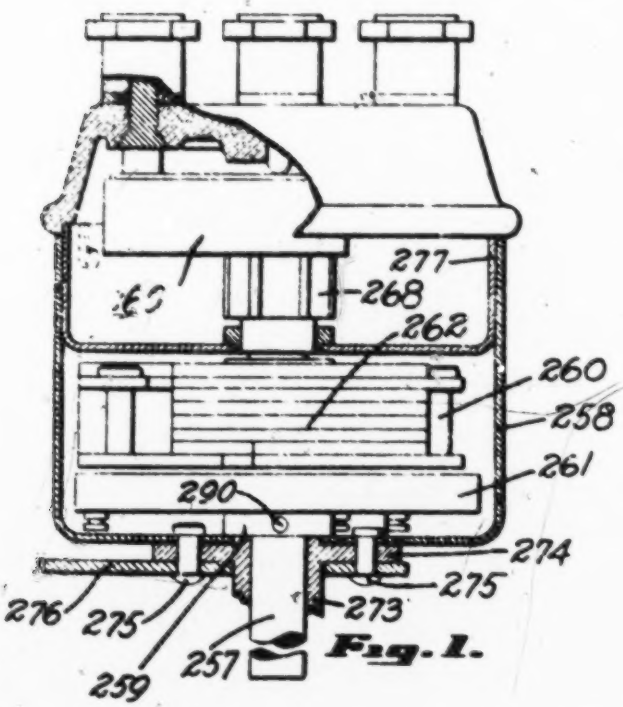

Fig. 1.

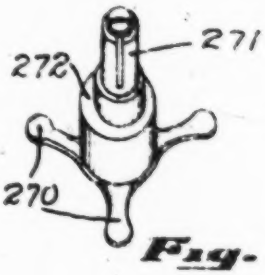

Fig. 4.

Fig. 5.

Witnesses
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William A. Chryst
By Kerr, Page, Cooper & Hayward.
Attorneys.

Patented Aug. 21, 1923. 1,465,644

UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING AND WILLIAM A. CHRYST, OF DAYTON, OHIO, ASSIGNORS TO THE DAYTON ENGINEERING LABORATORIES COMPANY, A CORPORATION OF OHIO.

IGNITION APPARATUS.

Original application filed October 4, 1915, Serial No. 55,160. Divided and this application filed September 16, 1918. Serial No. 254,175.

To all whom it may concern:

Be it known that we, CHARLES F. KETTERING and WILLIAM A. CHRYST, citizens of the United States, residing at Dayton, county of Montgomery and State of Ohio, have invented certain new and useful Improvements in Ignition Apparatus, of which the following is a full, clear, and exact description.

This invention relates to ignition timing and distributing devices for internal combustion engines and the like, and particularly to the type of apparatus disclosed in our patent No. 1,303,831, dated May 13, 1919, of which this application is a division.

One of the objects of this invention is to provide an ignition unit, wherein the time of occurrence of the sparking impulses in the ignition circuits may be automatically controlled, or may be manually or mechanically controlled, as may be desirable.

It is a further object of the present invention to combine the automatic control of the ignition system in such a manner that this type of control will automatically actuate the timer cam, and the rotor of the distributor, by the movement of these parts, relative to the timer contacts and the distributing contacts, respectively, in combination with a manually operated control which is arranged to actuate the timer contacts and the distributor contacts, relative to the timer cam and the rotor of the distributor.

A further object is provide an ignition timing and distributing unit in which the construction is greatly simplified in order to reduce the amount of material and the cost of manufacture.

A further object is to provide an ignition timing and distributing unit in which the construction has been standardized in order that many parts will be common to a series of such units which may differ from one another in order to suit the requirements of different engines.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:—

Fig. 1 is a view in elevation of a timing and distributing unit for the ignition system embodied in the present invention, certain of the parts of this unit being shown in section for the sake of clearness.

Fig. 2 is a top plan view of the unit disclosed in Fig. 1, with the distributor head and the casing, carrying the timer contacts and rotor of the distributor, removed to more clearly disclose the centrifugal governor or control.

Fig. 3 is a top plan view similar to Fig. 2, with the casing carrying the timer contacts and showing the timer cam in position.

Figs. 4 and 5 are detail views of certain of the elements embodied in the ignition unit.

By referring to the drawings, it will be seen that a shaft 257 extends into a casing 258, but this shaft is operable relative to said casing, and is not connected thereto. The shaft 257 may be termed the driving shaft of the ignition unit, but it is not thought necessary to describe or illustrate the driving connections between this shaft and the engine actuated parts, inasmuch as these connections are clearly described in our patent No. 1,229,754, dated June 12, 1917.

This shaft is pinned to a collar 259, by means of the pin 290, said collar being formed integral with or secured to the disc 261. This disc or plate 261 carries a plurality of pins 260, which form pivotal mountings for weight elements 262, see Figs. 1 and 2 particularly. Each of these weights is preferably made up of a number of different punchings or formed pieces, as is clearly shown in Fig. 1, but, of course, may be made of a single solid piece if so desired.

By using fabricated weight elements formed by a series of punchings, it is possible to vary the mass of the weight elements simply by varying the number of punchings. Therefore in constructing ignition units to meet different engine requirements, the weight members employed can be constructed from punchings of the same size.

The free ends of the respective weight elements are connected to the disc 261, by

means of the resilient or flexible connections 263, which in the present instance constitute coil springs. One end of each of these springs is secured to a pin 264, carried by the weight elements, while the opposite ends of said springs are connected to points 265, which are carried by the disc 261. These springs normally maintain the weights in what may be termed closed position. Each of the weight elements are provided in turn with a flanged portion or bottom plate 266, provided with a notch 267, which is adapted to receive an arm 270 of the spider 272, see Figs. 2 and 4.

This spider forms the carrying element for the timer cam 268, and the rotor 269 of the distributor.

By referring to Fig. 3, the relative location of the timer cam 268 and the timer contacts is clearly shown, while in Fig. 1, the relative location of the rotor of the distributor and the distributor contacts is clearly shown.

The spider 272, shown in detail in Fig. 4, comprises a plurality of arms 270, so spaced as to readily engage within the notches 267 formed in the weights 262, each of these arms having an enlarged rounded end portion to snugly fit within the notch formed in the weight, and still readily permit movement of the weight relative to the arm. This spider is connected to the driving shaft 257 solely by its connection above described, with each of the weight elements 262.

The upper end of the spider is provided with a reduced portion 271, which carries the timer cam 268 and the rotor of the distributor, as described hereinafter.

The casing 258 which contains the elements heretofore described, and through which the shaft 257 passes, is provided with a sleeve 273 having a flange portion 274, said sleeve surrounding the shaft 257 and being connected to the casing 258, by means of fastening bolts or rivets 275, which also secure a suitable handle or operating rod 276 rigidly to the casing.

From the above description, the operation of the device shown in Figs. 1 to 5 inclusive, will be as follows:

When the engine or other driving means actuates the shaft 257, the disc 261, the weight elements 262 and the spider 272 which carries the timer cam and rotor of the distributor will all turn the rod concomitantly with the shaft 257.

Now, as the speed of this shaft increases, which of course is the equivalent to the speed of the engine increasing, the weight elements 262, under the effect of centrifugal force, will tend to fly apart, against the tension of the springs 263. The movement of the weights 262, due to the effect of centrifugal force, will be transmitted to the timer cam and rotor of the distributor, through the connection of the weights with the spider element 272.

It will therefore be seen that as the weights move outwardly, the timer cam will be moved relative to the timer contacts and will therefore effect an advance in the time of closing the primary circuit of the ignition system, and inasmuch as the rotor of the distributor is carried by the same member as the timer cam, the time of closing the secondary circuits by the operation of the rotor of the distributor, relative to the distributor contacts, will be advanced or moved in exactly the same proportion as the timer cam.

However, it will be appreciated that under certain conditions, it may be desirable to manually control the time of occurrence of the sparking impulses, and in the present instance, this is effected by connecting the casing which carries the distributor contacts and the timer contacts with a controlling member which may be readily actuated by the operator, to advance or retard the time of occurrence of the sparking impulses.

The timer contacts are mounted within a cup 277, which fits within the casing 258, and is secured thereto in any suitable manner by means of a bayonet joint construction. This cup is prevented from movement relative to the outer casing, not only by means of this bayonet joint construction, but also by providing a spring 278a, one end of which projects through an opening formed in this inner casing, pressing against the inner face of the outer casing as at 278. The opposite end of said spring is connected to the movable contact element 279, which is adapted to be moved into and out of contact with the fixed contact 280, and thereby controls the making and breaking of the primary circuit of the ignition circuit.

This movable contact element comprises a plate 281, formed to provide a pair of lugs 282, between which the contact roller 283 is suitably positioned. From the above, it will be seen that the spring 278a not only tends to prevent relative movement between the cup 277 and the outer casing 258, but it also tends to maintain the movable contact plate 281 in engagement with the stationary contact point 280, except when the same is actuated by the lobes of the timer cam.

By providing a timer cup which is readily removable from the timer casing, repair and replacement of units and parts of the apparatus are facilitated.

While the form of mechanism herein shown and described constitutes a preferred form of embodiment of the present invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow:

1. In an ignition timer, the combination with a casing and a drive shaft supported for rotation thereby; of a disc mounted on

said shaft; a plurality of laminated weight members pivotally mounted on said disc, each weight member having a bottom plate adjacent the disc provided with a notch and other plates mounted on said bottom plate; springs restraining movement of the weights located below the disc; a cam support mounted for rotation within the casing and having arms located in the plane of the bottom plates of the weight members, each arm being received by one of said notches; a timer cam mounted on the cam support above the weight members; breaker mechanism controlled by the cam; and a support for the breaker mechanism located between the cam and weights.

2. In an ignition timer, the combination with a casing and a drive shaft supported for rotation thereby; of a disc mounted on said shaft; a plurality of weight members pivotally mounted on said disc, and each provided with a notch located below the top surface of the weight; springs for restraining movement of the weights located below the disc; breaker mechanism located above the weights; a support for said mechanism located closely adjacent the weight members; a cam support including arms cooperating with said notches and rotatably mounted within the casing; and a cam mounted on the cam support above the breaker support.

3. In an ignition timer, the combination with a casing and a drive shaft supported for rotation thereby; of a disc mounted on said shaft; a plurality of weight members mounted on said disc; springs for restraining the weight members; a breaker support located above the weight members; a bearing mounted on the breaker support; a cam support cooperating with the weight members below the breaker support and journalled upon said bearing; a cam mounted on the cam support above the breaker support; and breaker mechanism mounted on said breaker support; said breaker support being removable from the casing without disturbing the weights and springs, and carrying with it the cam and cam support all in assembled relation.

In testimony whereof we affix our signatures.

CHARLES F. KETTERING.
WILLIAM A. CHRYST.

Witnesses:
J. W. McDONALD,
GRIER MARÉCHAL.

July 19, 1927. 1,636,017

W. F. SMITH

MAGNETO

Filed Dec. 5, 1924 3 Sheets-Sheet 1

Fig. 1.

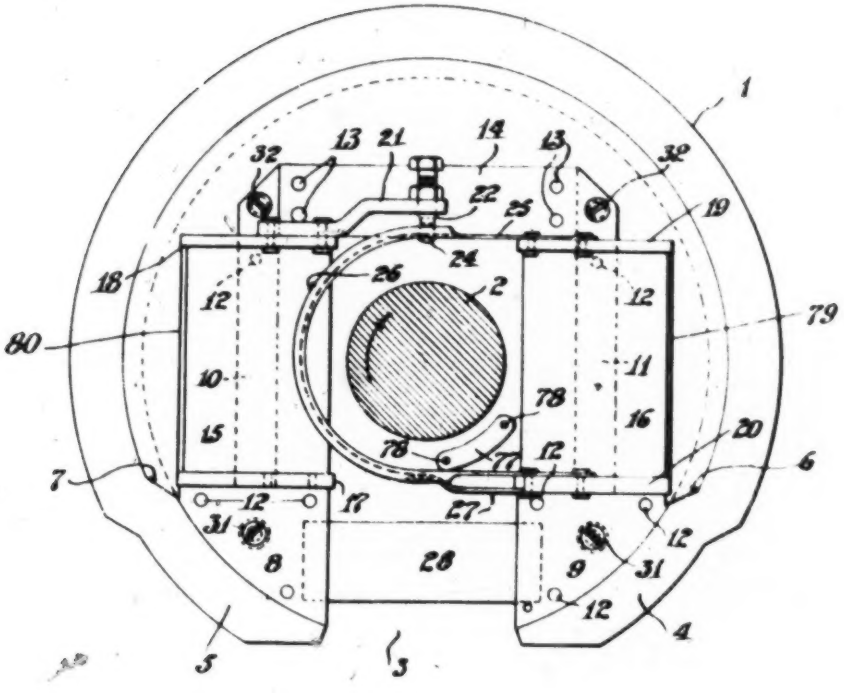
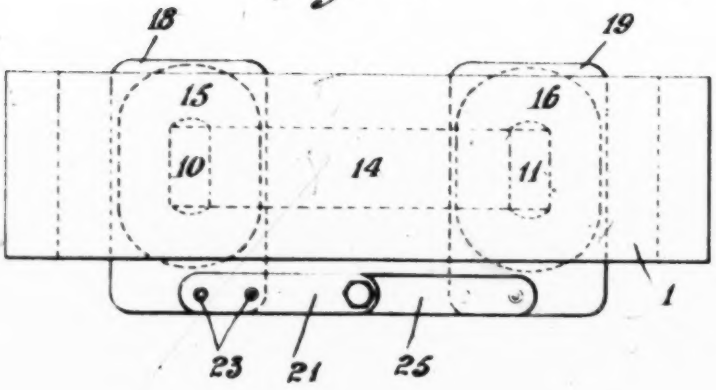


Fig. 2.



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BY Parker & Hinds
ATTORNEY

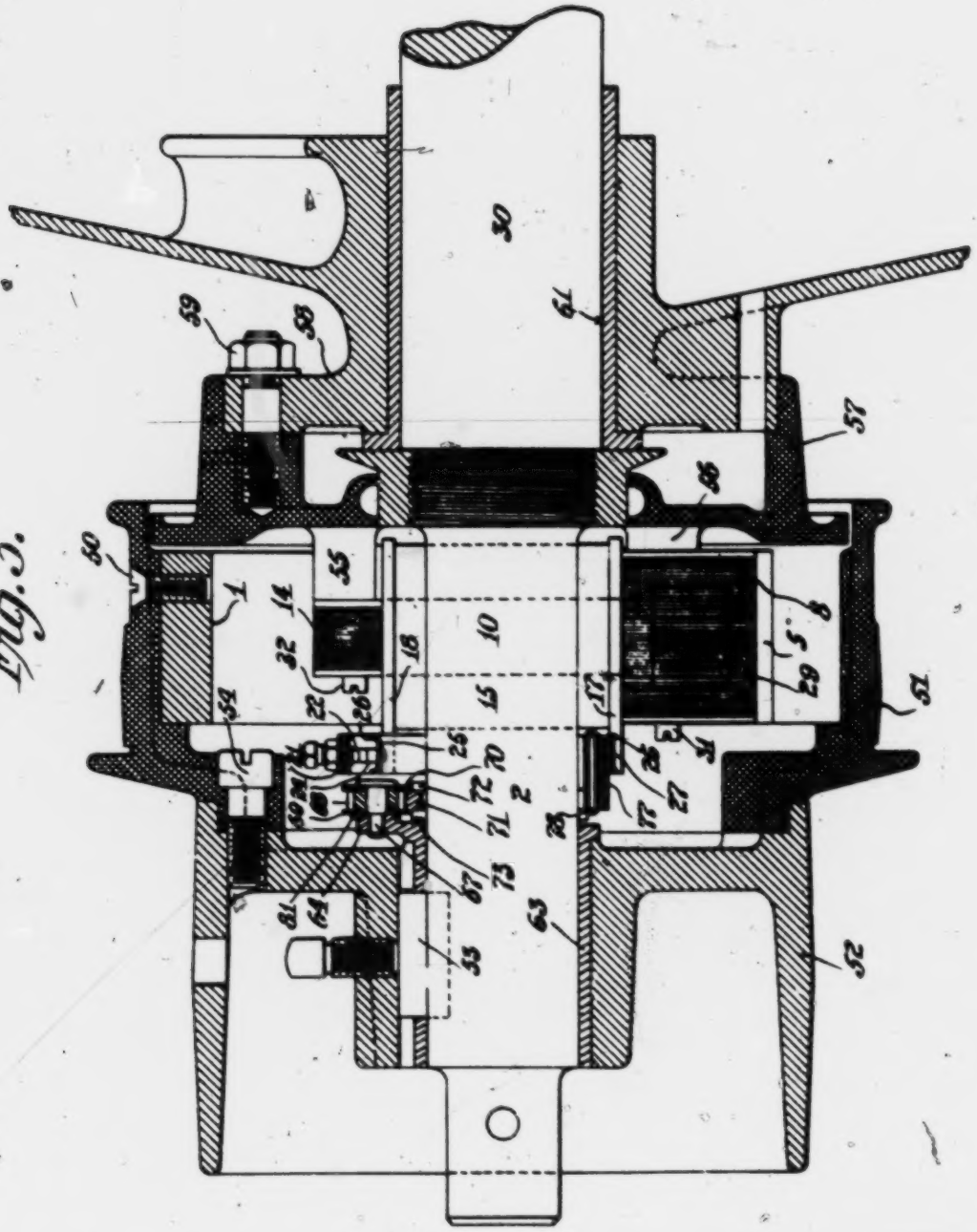
July 19, 1927. 1,636,017

W. F. SMITH

MAGNETO

Filed Dec. 5, 1924 3 Sheets-Sheet 2

Fig. 3.



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MAGNETO

Filed Dec. 5, 1924 3 Sheets-Sheet 3

Fig. 4.

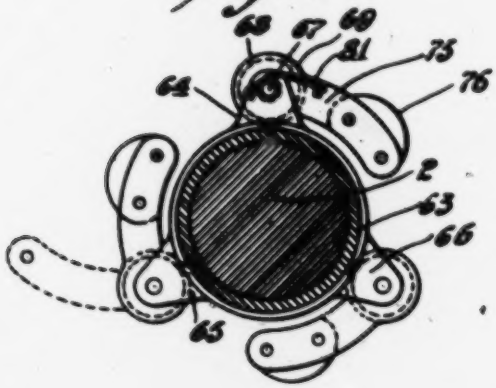


Fig. 5.

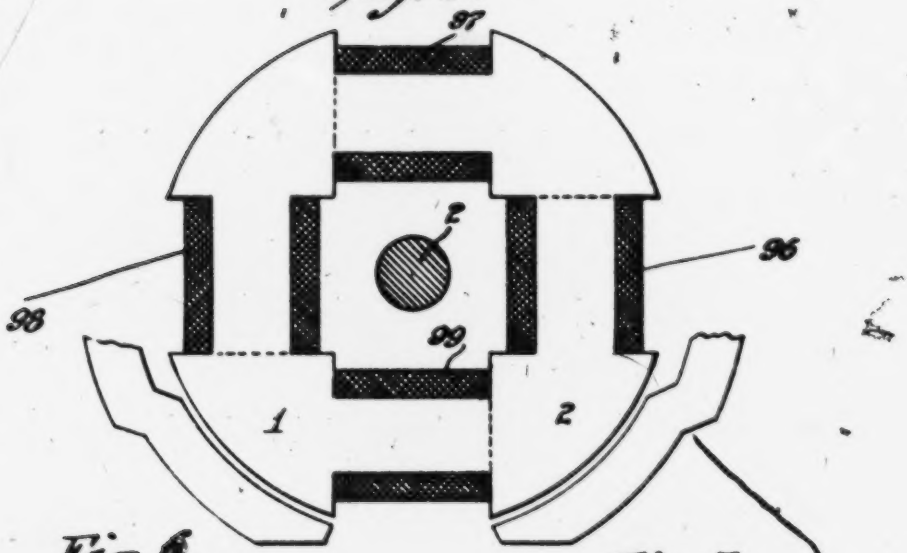


Fig. 6.

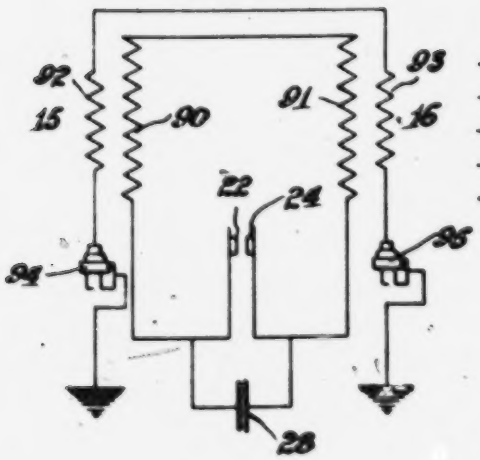
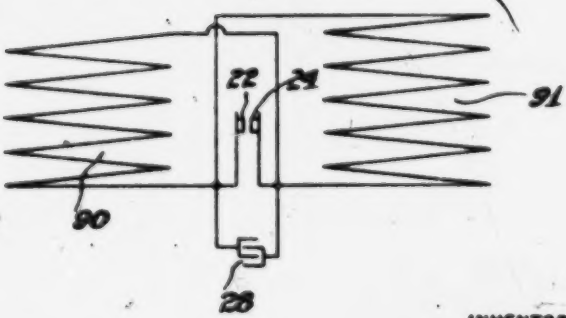


Fig. 7.



INVENTOR
W. F. Smith
BY
his ATTORNEY

Patented July 19, 1927. 1,636,017

UNITED STATES PATENT OFFICE.

WILLIAM F. SMITH, OF POUGHKEEPSIE, NEW YORK, ASSIGNOR OF ONE-HALF TO HERMAN A. SCHAFF, OF POUGHKEEPSIE, NEW YORK.

MAGNETO.

Application filed December 8, 1926. Serial No. 753,114.

This invention relates to improvements in magneto-electric generators adapted for a variety of uses, though more particularly constructed to be employed in conjunction with internal combustion engines.

The purpose of the present invention is to provide a magneto of compact and sturdy construction and adapted to operate as an efficient ignition apparatus for internal combustion engines. The various features of the invention have to do with the construction of the magnet and armature structures and their mounting on a crank-shaft extension of an internal combustion engine, an improved automatic ignition timing means, and other features described in the following detailed description and the appended claims. The invention is disclosed as applied to the crank-shaft of a single cylinder internal combustion engine and a tractor propelled by it described and claimed in my copending applications, Serial Nos. 722,360 and 715,536, filed June 26, 1924 and May 23, 1924, respectively. It will be obvious, however, to those skilled in the art that the various features of the invention are capable of a wide variety of different uses without departing from its spirit.

The preferred embodiment of the invention is illustrated in the drawings in which Fig. 1 is a plan view of the magneto structure; Fig. 2 is a sectional view along lines 2—2 of Fig. 1; Fig. 3 illustrates in vertical cross-section the magneto mounted on an extension of the crank-shaft of an internal combustion engine; Fig. 4 is an enlarged view of the spark advance controlling mechanism; Fig. 5 illustrates in plan view a modified structure; and Figs. 6 and 7 are illustrations of two circuit diagrams adapted for use in conjunction with the magneto.

Referring now to Figs. 1 and 2 of the drawings, a substantially circular permanent magnet 1 mounted on an extension 2 of the crank-shaft is arranged to rotate therewith in the direction of the arrow. The ends of the permanent magnet 1 are separated by an air-gap 3, these ends being formed into polepieces 4 and 5. Instead of attaching separate polepieces to the permanent magnet 1, the ends of the magnet are upset at 6 and 7, raising the inner faces of the polepieces 4 and 5 into close proximity with pole heads 8 and 9 of the armature cores 10 and 11. The laminated pole heads 8 and 9 form a unitary structure with the cores which are built up of iron laminations in the form of stampings of a contour clearly illustrated in Fig. 1. The laminations are held together by means of rivets 12, and the upper ends of the core laminations are dove-tailed into the ends of a laminated yoke 14. The laminations of the yoke are riveted together at 13.

Coils 15 and 16, each comprising primary and secondary windings, surround the cores 10 and 11. The coils are provided with spool heads 17, 18 and 19, 20 of insulating material. A bracket 21 carrying an adjustable contact point 22 is riveted to the spool head 18 at 23. The contact 22 cooperates with contact 24 carried by a leaf spring 25, the two ends of which are riveted respectively, to the spool heads 19 and 20. The spring 25 has two upturned flanges 26 to give it rigidity, the spring being normally pressed with its contact 24 into engagement with the contact 22 by means of a leaf spring 27 riveted to the under side of the spool head 20. A condenser 28 is held between the pole heads 8 and 9 within recesses such as 29 provided by cutting away portions of some of the laminations that go to make up the pole heads 8 and 9.

Referring now to Fig. 3, the manner in which the magneto is mounted on an extension 2 of the crank-shaft 30 of an internal combustion engine will be explained. The permanent magnet 1 is held by means of screws like 50 against a casting 51 of aluminum or other non-magnetic material which in turn is secured by means of screws like 54 to a casting 52 keyed to the shaft 2 at 53. The castings 51 and 52 (the outside surface of the latter serving as a belt-drive) rotate therefore with the shaft 2. The armature core is fastened by means of screws 31 and 32 into bushings 55 and 56 projecting from a casting 57 of non-magnetic material. The screws project through the pole heads 8 and 9 and the ends of yoke 14. The casting 57 is rigidly held against the crank-shaft casing 58 by means of bolts like 59. The casing 58 is stationary with respect to shaft 30 which is free to rotate within a sleeve bearing 61 provided in the casing. It should be noted in this connection that the whole magneto structure is made accessible for inspection or repair simply by removing casting 52 without dismantling the internal combustion engine.

The key 53 serves also to fasten to the

shaft 2 a sleeve 63 from the end of which project three brackets 64, 65 and 66 (see Fig. 4). Each bracket carries a pin 67 on which is mounted between two guides 69 and 70 a pinion 68. The guides project beyond the teeth of the pinions 68 and hold against lateral displacement a gear 71 provided around the shaft 2. The gear 71 is provided with shoulders 72 and 73 against which the ends of the guides 69 and 70 abut. There is a clearance between the shaft 2 and the gear 71 and the latter is supported only by the three pinions 68 intermeshing therewith. Each guard of the pinions 68 is provided with an arm 75, and a weight 76 is carried between the ends of each pair of arms. A cam 77, built up of fibre or other insulating laminations and adapted to engage the spring 25 is fastened to the gear 71 by means of rivets 78.

During the rotation of the shaft 2 the casting 51 is caused to rotate with the permanent magnet 1, the polepieces 4 and 5 of which, in passing by the pole heads 8 and 9 of the armature cause, in the well-known manner, the magnetic flux to pass through the core 10, 11 and yoke 14, and this in turn results in the generation of alternating current fluctuations in the secondary windings, and by induction, with primary windings of coils 15 and 16. The pole pieces 4 and 5 are so dimensioned that they span the gap 3 between the pole heads 8 and 9, whereby the magnetic flux is short-circuited twice during each revolution of the permanent magnet 1. Inasmuch as the electrical characteristics of such magneto structures are well known in the art, their description will be dispensed with. It should be noted, however, that owing to the type of magnet structure used, losses which result from interruptions in the magnetic circuit when separate polepieces are fastened to the ends of the permanent magnet are entirely avoided by forming the polepieces 4 and 5 homogeneously with the magnet 1. The magnet 1 and the armature structure being rigidly mounted on heavy castings, the maintenance of a very narrow air-gap between the polepieces and the pole heads is insured. In order to prevent the setting up of an opposing flux through the cores 10 and 11 when one polepiece of the permanent magnet 1 passes by a pole head and the other polepiece by the upper end of the core (see Fig. 1 in which the path of the polepieces is indicated in a dotted circle), iron shields 79 and 80 are provided. These shields are in the form of strips, the ends of which are fastened to the spool heads 17, 18 and 19, 20, respectively, and serve to afford a shunt path for the magnetic flux when the polepieces 4 and 5 pass near the ends of such shields.

The sleeve 63 being also rotated with the shaft 2 will drive the gear 71, through the agency of the three pinions 68, at the same rate of speed as the shaft is rotated, and each time that the cam 77 engages the spring 25 at or near the point where it is pressed upward by the leaf spring 27, it will force these springs down, causing the opening of the primary circuit in contacts 22 and 24.

The arms 75 are normally held down by means of springs 81 wound around the heads of the brackets 64, 65 and 66 and having their ends attached to the arms 75 and brackets 64, 65 and 66, respectively. When the speed of rotation of shaft 2 is increased then owing to the centrifugal action of the weight 76, the arms 75 will be moved into or towards the positions indicated in dotted lines in Fig. 4. Such movement of an arm 75 will cause the associated pinion 68 to rotate, which movement is transmitted to the gear 71. The gear 71 is thus caused to advance in addition to the above described rotary motion normally imparted by the pinions, whereby the cam 77 will engage the spring 25 at a point to the left of the one indicated in Fig. 1. Depending, therefore, on the speed at which the shaft 2 is rotated, i. e., on the speed of the internal combustion engine the opening of the primary circuit is automatically timed to occur at more or less advanced positions of the crank-shaft and therefore of the piston or pistons carried by this shaft.

The automatic spark advance arrangement is provided in a manner to make possible a simple and compact arrangement. The gear 71 being out of contact with shaft 2, oiling of the parts which would detrimentally affect the electrical contacts is avoided. Furthermore, the predetermined setting of gear 71 and the pinions 68 is not disturbed by wear, as would be the case if some solid coupling were provided between the shaft and the gear. Another important feature of this arrangement consists in that the relative adjustments of the armature and magnet are not interfered with by its operation.

The electrical circuit connections may be provided in any one of a plurality of suitable combinations. Fig. 6 illustrates a circuit in which the primary coils 90, 91 are connected in series with the interrupter springs 22, 24, the latter being shunted by means of condenser 28 to eliminate sparking. The secondary coils 92, 93 are also connected in series and each with one electrode of spark plugs 94 and 95 the other electrodes of these plugs being grounded.

In the circuit diagram illustrated in Fig. 7, the primary coils 90 and 91 are connected in parallel with each other and with the contacts 22 and 24.

Fig. 5 illustrates the manner in which four coils 96, 97, 98 and 99 may be mounted in the structure herein disclosed, the dotted lines indicating where the cores and pole

heads of adjacent coils come in contact with each other.

What I claim is:

1. In a magneto, a shaft, means for rotating said shaft at varying speeds, a magnet carried by said shaft, a stationary armature, contacts in the armature circuit, and means comprising a gear and pinion responsive to the speed at which said shaft rotates for opening said contacts in different rotary positions of said shaft.

2. In a magneto, a shaft, means for rotating said shaft at varying speeds, a stationary armature, contacts in the armature circuit, a gear rotating at the speed of said shaft but free to revolve with respect thereto, a cam carried by said gear for opening said contacts, and means responsive to the speed at which said shaft rotates for causing said gear to revolve independently of said shaft.

3. In a magneto, a shaft, means for rotating said shaft at varying speeds, a stationary armature, contacts in the armature circuit, a pinion carried by said shaft and revolving therewith, means responsive to the speed of said shaft for rotating said pinion relative to said shaft, a gear intermeshing with said pinion, and a cam carried by said gear for actuating said contacts.

4. In a magneto, a shaft, means for rotating said shaft at varying speeds, a stationary armature, contacts in the armature circuit, a rotating element, a cam carried thereby for actuating said contacts, another element fastened to said shaft and in operative contact with said rotating element, and means responsive to the speed of said shaft for rotating said other element to displace said rotating element.

5. In a magneto, a rotating shaft, a magnet carried thereby, an armature including a primary and a secondary winding, contacts in the circuit of said primary winding three pinions fastened to said shaft, a gear supported by and intermeshing with said pinions, and means carried by said gear for actuating said contacts.

6. In a magneto, a rotating shaft, a substantially circular permanent magnet surrounding said shaft and carried thereby, a stationary armature including a primary and a secondary winding surrounded by said magnet, contacts in the circuit of said primary winding, a sleeve fastened to said shaft, three brackets radially projecting from said sleeve, a pinion carried by each bracket, two guard plates of larger diameter than said pinions mounted on each pinion, eccentric weights carried by said guard plates, springs normally forcing said weights towards said shaft, a gear provided with lateral shoulders surrounding said shaft but free thereof, the teeth of said gear being in mesh with the teeth of said three pinions and said gear being held against lateral and vertical displacements by the edges of the guard plates engaging the shoulders on said gear, a leaf spring bent in a semi-circle and held at both ends carrying one of said contacts, and a cam fastened to said gear and adapted to engage said spring at any one of a plurality of points to cause the separating of said contacts.

7. In a magneto, an operating shaft, means for rotating said shaft at varying speeds, an armature circuit, contacts in said circuit, a cam arranged to open said contacts during each revolution of said shaft, and means comprising a gear and pinion responsive to the speed at which said shaft rotates for causing said cam to actuate said contacts in varying angular positions of said shaft.

8. In a magneto, a magnet, an armature comprising a core and a coil mounted thereon, insulating spool heads for said coil, a contact in the armature circuit, and a spring carrying said contact fastened with its two ends to said spool heads.

9. In a magneto, a magnet, an armature comprising two coils, spool heads for said coils, two cooperating contacts in the armature circuit, a bent leaf spring carrying one of said contacts fastened with its two ends to two spool heads, and a bracket carrying the other contact fastened to another spool head.

10. In a magneto, a substantially circular permanent magnet the ends of which are upset to form polepieces, a laminated armature core having laminated pole heads in close proximity to said polepieces, two coils each comprising a primary and a secondary winding mounted on said core, spool heads of insulating material for said coils, a leaf spring bent in a semi-circle and having its ends riveted to the spool heads of one of said coils, a contact point carried by said leaf spring, an adjustable contact point cooperating with said first mentioned contact and mounted on a spool head of the other coil, and a cam for actuating said leaf spring.

11. In a magneto, a shaft, a magnet carried thereby, an armature comprising two cores straddling said shaft and surrounded by said magnet, contacts in the armature circuit, a spring carrying one of said contacts partially encircling said shaft, and a cam between said shaft and spring for actuating the latter.

12. In a magneto, a shaft, a magnet carried thereby, an armature comprising two cores straddling said shaft and surrounded by said magnet, contacts in the armature circuit, a leaf spring carrying one of said contacts and partially encircling said shaft beyond the plane of said magnet, a cam between said shaft and spring for actuating

the latter, and means for causing said cam to rotate around said shaft.

13. In a magneto, a substantially circular permanent magnet the ends of which are upset to form polepieces separated from each other, two laminated cores parallel with each other, a laminated yoke interconnecting the cores at one end, laminated pole heads on the other ends of said cores and projecting in close proximity to said polepieces, the distance between said pole heads being such that they may be spanned by a polepiece, a coil on each core comprising a primary and a secondary winding, spool heads of insulating material for said coils, a magnetic shield for each core mounted on the spool heads of the associated coil, a leaf spring bent in a semi-circle and having its ends riveted to the spool heads of one of said coils, a contact point in circuit with said primary windings carried by said spring, an adjustable contact point cooperating with said first mentioned contact, a bracket carrying said adjustable contact fastened to one of the spool heads of the other coil, and a cam for actuating said spring.

14. In a magneto, a rotating shaft, a casing through which said shaft projects, a non-magnetic casting fastened to said casing, two parallel armature cores straddling said shaft mounted on said casting, a second non-magnetic casting overlapping said first mentioned casting and fastened to said shaft, and a permanent magnet attached to said second casting.

15. In a magneto, a magnet, an armature core, a pole head for said core, a recess in said pole head, and a condenser held in said recess.

16. In a magneto, a magnet having two polepieces, an armature comprising two pole heads cooperating with said polepieces, and a condenser held between said pole heads.

17. In a magneto, a magnet having polepieces, an armature comprising two opposite pole heads cooperating with said polepieces, recesses in opposite faces of said pole heads, and a condenser fitted with its two ends in said recesses.

18. In a magneto, a rotating shaft, a casing through which said shaft projects, a disc of non-magnetic material mounted on said casing, armature core mounted on said disc, a second disc of non-magnetic material overlapping said first mentioned disc and fastened to said shaft, and a permanent magnet attached to said second disc.

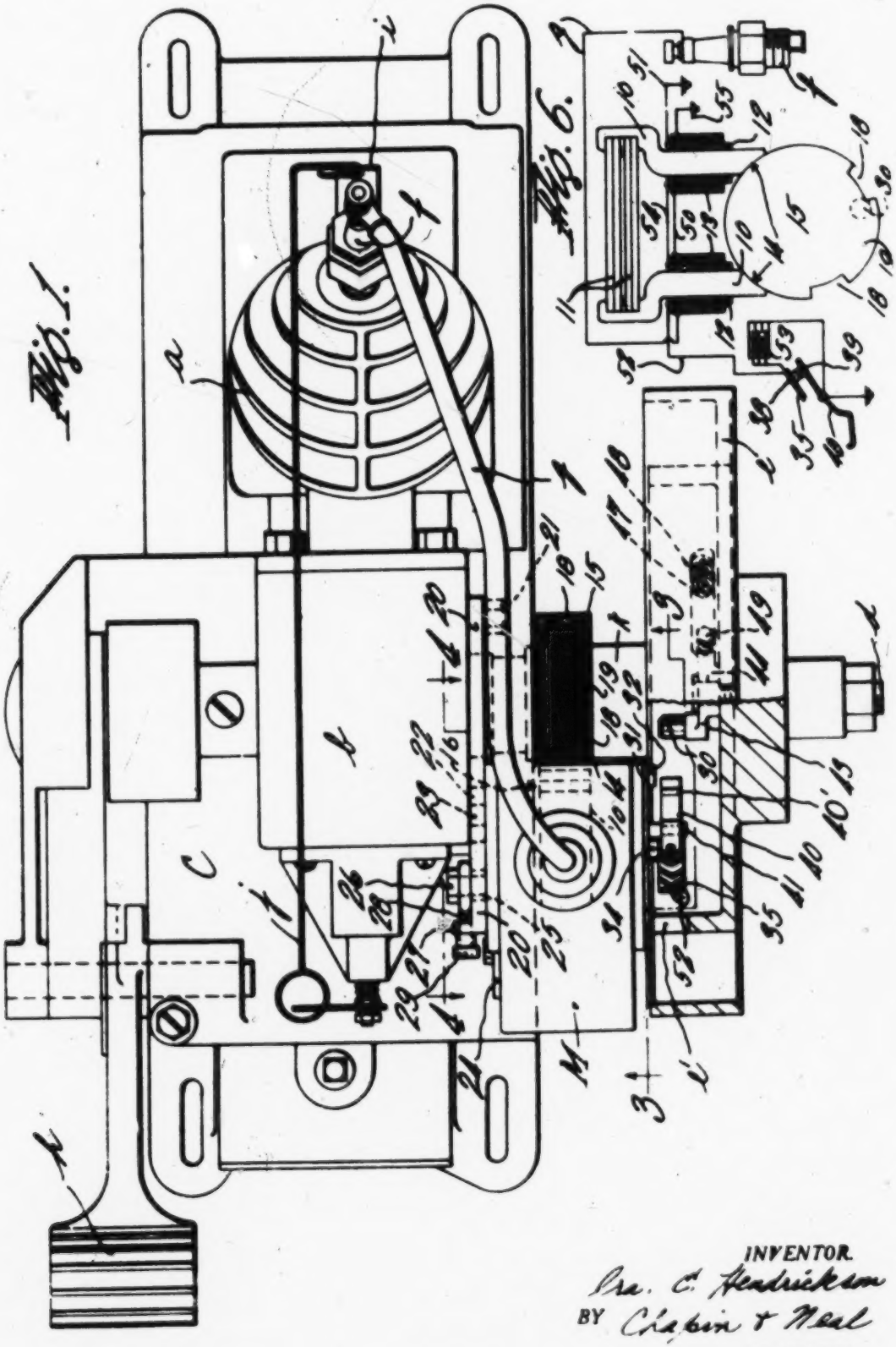
In testimony whereof, I have signed my name to this specification this 3rd day of December 1924.

WILLIAM F. SMITH.

Nov. 19, 1929. I. E. HENDRICKSON 1,736,441

MAGNETO

Filed Aug. 31, 1928 3 Sheets-Sheet 1



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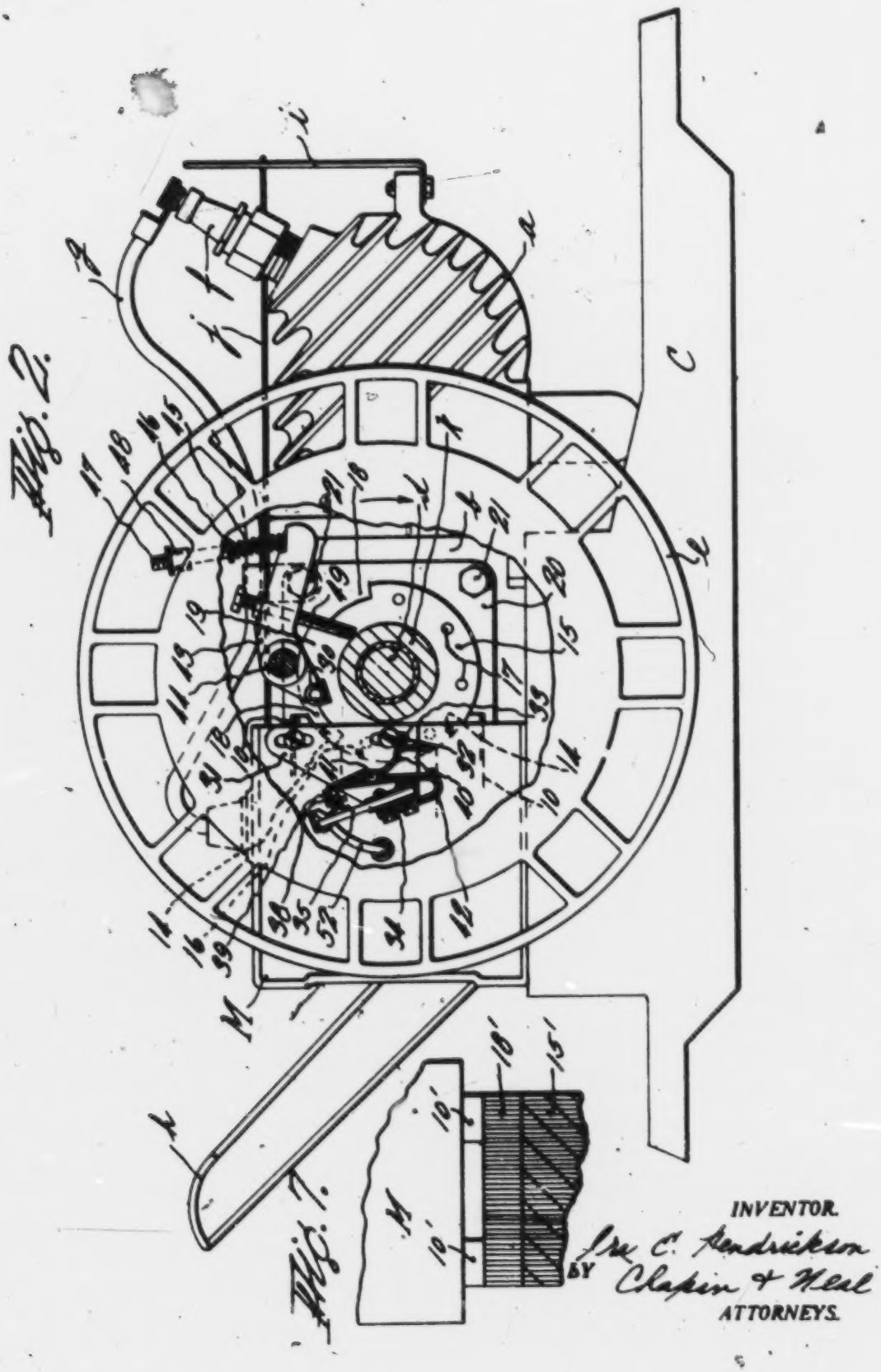
MAGNETO

Filed Aug. 31, 1928 3 Sheets-Sheet 2



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MAGNETO

Filed Aug. 31, 1928 3 Sheets-Sheet 3

Fig. 3.

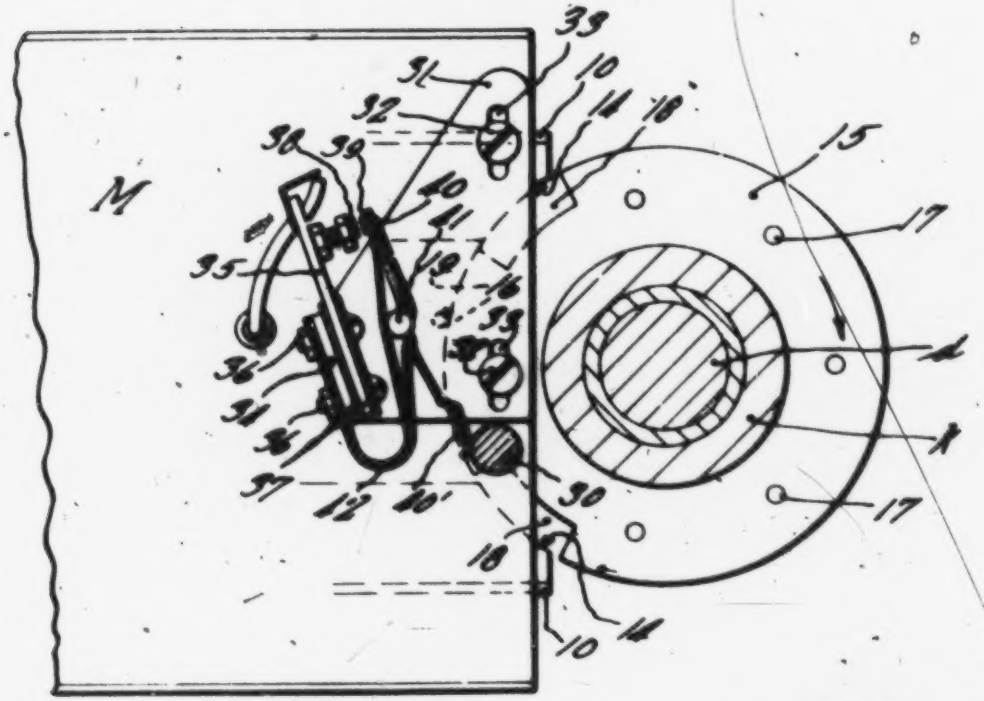


Fig. 4.

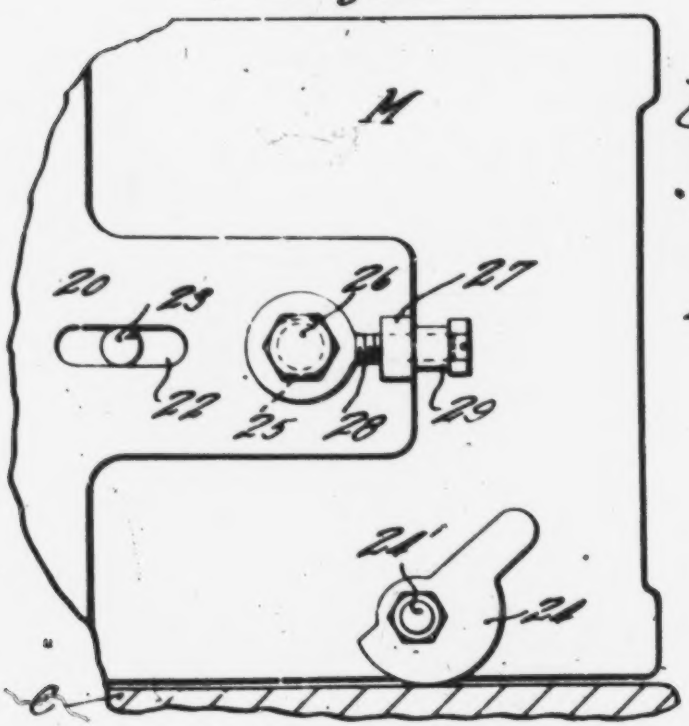
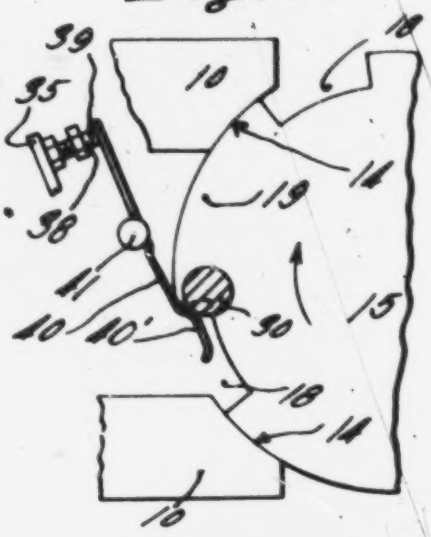


Fig. 5.



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Patented Nov. 19, 1929 1,736,441

UNITED STATES PATENT OFFICE

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MAGNETO

Application filed August 31, 1926. Serial No. 303,303.

This invention relates to an improved magneto of the type having an unwound, rotary inductor or armature,—sometimes known as the flywheel type when the flywheel is utilized as the inductor.

The prior art discloses a large number of magnetos of this type, which may for convenience be subdivided into two general classes. In one of these classes, the magnetic field elements,—except for the inductor,—and the generating coils are maintained stationary,—leaving the inductor as the only rotary element. In the other class, the magnets rotate. The only magnetos of the stated type which have had any substantial commercial success, so far as I am aware and have been able to determine, are of the second-named class and these have many disadvantages.

Contrasted with magnetos of the first class, magnetos of the second class are more expensive to manufacture. Also, their use leads to many complications. Usually they must be specially designed for each engine installation and thus "built into" the engine as distinguished from a unitary structure which can be added on to any engine without necessitating special design of engine parts. Long magnets, bent up into substantially circular form, are often used and these are expensive due to the special work in shaping them, as well as to the large amount of material involved. Such magnets have to be surrounded by non-magnetic material, which is more expensive than cast iron. For example, it is common to make the flywheel of aluminum. It is also common to house the magnets, as well as all other parts of the magneto in the flywheel. This practice makes the magneto relatively inaccessible,—difficult to install and difficult to remove when servicing is required. Also, it is not feasible in magnetos of the second class to reduce the clearance between the pole pieces and the inductor to such low limits as is practical in magnetos of the first class and, therefore, the former are less efficient than the latter, other factors being equal.

That there are so many disadvantages to magnetos of the second class has led me to direct my invention entirely to magnetos of the first class, and I seek by the utilization of a less amount of material in a less expensive way to produce better results. In this field, however, there are many troubles to be overcome. The prior art abounds in examples of magnetos of this class, but it is, I believe, a fact that no one of such magnetos has ever met with any substantial degree of commercial success. Something has been lacking in each instance which prevented a commercially successful solution of the problem. At intervals over a long period of years attempts have been made to solve this problem, but no one heretofore has happened to secure just the right combination of elements to admit of results which would bring full commercial success.

My invention is directed to, and has for its general object, the provision of a magneto of the first-named class which satisfies the exacting demands of commercial service. Various good features individually disclosed in the prior art have been retained and other bad features eliminated, and the result is a novel arrangement of elements cooperating in an improved way to produce successful results.

More particularly, I set forth the objects of my invention by stating conditions which I deem necessary to assure successful results in a magneto of the stated type and class. The magnets, cores, and coils should be stationary and assembled as one compact, unitary structure, which can be applied to any engine in a conveniently accessible location and without substantial alterations in the latter. This unit, which should include two magnetic pole pieces, should preferably be mounted for convenient adjustment toward or away from the rotary inductor in order to adjust the clearance between the rotor and pole pieces and, for efficient utilization of the magnetic flux, such clearance should be exceedingly small and as near physical contact as possible. For proper adjustment and maintenance of such clearance, it is essential that both pole pieces should lie on the same side of the engine crankshaft. Due to the lack of actual contact between the arma-

ture and pole pieces, it is essential that the magneto have both primary and secondary coils,—otherwise, the spark produced will be too feeble to satisfy the requirements. The inductor, for maximum efficiency, must provide for a sharp and double break in the magnetic circuit and, so far as is practical, must at other times hold the magnetic circuit closed. A simple form of breaker point mechanism should preferably be used to control the primary circuit, which requires one opening and closing for each cycle of operation of the magneto. These breaker points should normally hold the primary circuit closed and should preferably open at substantially the time when the double break in the magnetic circuit occurs to allow the spark to be produced on breaking, rather than on making, of the magnetic circuit. The breaker points should close shortly thereafter. Preferably, the inductor should be so arranged as to move into position to at least partially complete the magnetic circuit before the breaker points close so that a substantial building up of flux occurs under the favorable condition of an open circuited primary winding. The inductor should hold the magnetic circuit closed as long as possible to hold such flux as has been built up, during the instant that the breaker points are open, and also to allow time for additional building up of the flux, if and when necessary, under the slower and less favorable condition of a closed circuited primary winding.

So far as I am aware there has been no magneto heretofore which will satisfy all these conditions and therein I believe is the reason for the failure of magnetos of this class to attain commercial success.

Perhaps the closest approach to a satisfactory solution of the problem is disclosed in the Clark Patent No. 1,486,229, dated March 11, 1924, which states many of the difficulties encountered in magnetoes of this type and offers as a solution a special quick-opening and quick-closing breaker-point mechanism. Such mechanism leads to complications which I desire to avoid. As distinguished from the Clark patent, I have provided a different type of inductor, which enables me to dispense with the necessity of using his special breaker point mechanism and enables me to utilize one of ordinary construction. At the same time, by so doing, I have secured greatly improved results, in so far as spark output is concerned.

It is another object of my invention to utilize, with comparatively little modification, a magneto of a standard and efficient type, which has met with substantial commercial success, when used with a reciprocating and contacting armature. Such magnetos have for some time been produced in large quantities and are available at low cost. By a slight change in the shape of the polar faces and a change in the breaker point mechanism, this magneto is suitable for use with a rotary inductor. I need, then, to provide merely a simple mounting to support the magneto unit from the engine and to place a rotary inductor on the crank shaft or other suitable rotary part of the engine, in order to equip any engine with a satisfactory rotary inductor type magneto and this can be done at a cost far lower than that of magnetoes of the second-named class, as above defined.

Other objects and advantages will appear from the following description and will be pointed out in the appended claims.

The invention will be disclosed with reference to the accompanying drawings, in which—

Fig. 1 is a plan view, with parts broken away, showing a magneto, embodying my invention, applied to an internal combustion engine;

Fig. 2 is a side elevation view thereof,—a part of the flywheel being broken away to reveal the magneto;

Figs. 3 and 4 are fragmentary sectional views taken on the lines 3—3 and 4—4, respectively, of Fig. 1;

Fig. 5 is a diagrammatical view taken similarly to Fig. 3 but showing a different relative positioning of parts;

Fig. 6 is a diagrammatical view illustrative of the magnetic and electrical circuits of the magneto; and

Fig. 7 is a fragmentary longitudinal sectional view illustrative of a modification.

Referring to Figs. 1 and 2, the invention has been illustrated as applied to a standard type of small internal combustion engine. Such engine, in so far as a description of it is necessary to an understanding of this invention, includes a single cylinder *a*, bolted to a crank case *b*, mounted on a suitable bed plate *c*. The crankshaft is indicated at *d* and carries a flywheel *e* of usual form and material. A spark plug *f* is connected by a high tension cable *g* to the magneto unit M. The pedal *h* is part of the usual mechanism for cranking the engine. To stop the engine, a flexible, metallic arm *i*, secured to cylinder *a* and thereby grounded, is arranged to be flexed and drawn into contact with the terminal of the spark plug *f* by pulling on the wire *j*. The particular engine shown is of the two cycle type. Accordingly, for this particular engine, the magneto is required to produce one spark per revolution. This engine, of course, is merely illustrative of one of many suitable types with which my magneto may be used and other installations may require a different number of sparks per revolution.

The magneto unit M may be of any suitable type embodying a magnetic source and a pair of cores with primary and secondary coils

thereon. Such parts are shown conventionally in Fig. 6, wherein two cores 10, connected one to each polar extremity of a bank of permanent magnets 11, carry primary and secondary coils 12 and 13, respectively, and terminate with polar faces 14 arranged to be engaged by an unwound rotary inductor 15. The unit M, except for the change in shape of the polar faces and a different form of inductor and breaker point mechanism is, or may be, like the magneto disclosed in Brown and Louis Patent No. 1,557,976, dated October 20, 1925, to which reference is made for a more complete disclosure. The parts described are all housed in a casing, as shown in the last named patent, forming a small compact unit easily handled and readily applied to any engine. The standard type of magneto shown in such patent may be used by removing the breaker point mechanism and substituting another later to be described, and by milling or otherwise shaping the lower ends of cores 10, and any intervening part, to conform to the curvature of the inductor. In Figs. 2 and 3 the cores 10 are indicated in part only but sufficiently to show the polar faces 14 and the recess 16 which permits the inductor 15 to rotate in close proximity to such faces.

The inductor 15 is simply a cylindrical body of magnetic material which is built up of circular laminations suitably held together, as by rivets 17, and which is substantially equal in length to the thickness of cores 10. This body is suitably fixed to turn with crankshaft *d*, as by being driven on to the hub *k* of flywheel *e*. The inductor, for the particular engine shown, is provided with two non-magnetic portions 18 which are so spaced as to simultaneously register with the two polar faces of cores 10, as shown in Fig. 3. These portions 18, as shown, are formed by notching the periphery of the inductor, but the prior art shows that notches filled with some metallic and non-magnetic material are equivalents for the purpose. The notches, or non-magnetic portions 18, are preferably a little wider than the polar faces 14 with which they cooperate. Otherwise, the optimum break in the magnetic circuit would not be obtained. The preferred length of each notch 18, relative to that of its polar face, has been shown in Fig. 3, and this has been found to yield the best magnetic break. Notches of any greater length add nothing to the effectiveness of the magnetic break and are bad because they interfere with the building up of flux and lessen the dwell period during which the magnetic circuit is closed, as will appear in greater detail hereinafter.

The effort in the present case has been to cut away as little of the periphery of the inductor as is practical and restrict the length of the non-magnetic portions 18 to the minimum necessary for the proper and most efficient performance of their function. The intervening part 19 is most important and without it successful results could not be obtained because this part, not only adds to the dwell period in which the magnetic circuit is closed, but also enables a substantial part, and it is believed, the larger part of the flux to be built up under the most favorable condition; i. e., before the breaker points close, as will appear in more detail hereinafter. Another important feature is that the notches 18 are spaced apart by an angle less than 180 degrees and therefore both notches lie on one side of the shaft as distinguished from a diametrically opposed relationship of such notches, which would render most difficult the adjustment and maintenance of the clearance between the inductor and polar faces within the small limits sought for in this case.

For the maximum efficiency the polar faces 14 should contact with the inductor and, while it is not feasible to obtain the intimate and actual contact of the inductor with these polar faces, which can be obtained in a magneto of the reciprocating armature type, the object here is to approach that condition as closely as is feasible. To this end, both polar faces 14 are located on the same side of the shaft and provisions are made whereby the unit M may be thrust bodily and in a radial direction to simultaneously carry both polar faces into exceedingly close proximity to the inductor with only what may be termed "rubbing" clearance. Any suitable means may be provided for this purpose.

As shown in Figs. 1 and 2, a plate 20 is suitably secured as by bolts 21 to one side of the crankcase *b* of the engine to serve as a support for the magneto unit M. In plate 20, there is a slot 22 (Figs. 1 and 4) which is disposed horizontally and substantially radially with respect to crankshaft *d*. A stud 23, fixed to the magneto unit M, projects into this slot and closely fits the same. This arrangement allows the magneto unit M to be moved radially in or out with respect to inductor 15 and also to be tilted up or down as may be necessary to bring the polar faces 14 into proper relation with the inductor and with equal clearance. A cam 24 (Fig. 4), fulcrumed at 24′ on the unit M, bears on bed plate *c*, and provides a means for tilting the unit M. The plate 20 also has a second slot, marked 25 through which a cap screw 26 passes. Slot 25 is wide enough to allow enough up or down play of stud 26 therein to enable the vertical adjustment of the unit M by cam 24 to be effected, and is long enough to permit the radial movement described. The outer end of plate 20 has an outwardly turned lug 27 in which the shank of an eyebolt 28 is slidable. The stud 26 passes through the eye of eyebolt 28 as well as through slot 25 and threads into the frame of the magneto unit M. Stud 26 serves to clamp such unit

in adjusted position. A nut 29 threaded on the outer end of the shank of eyebolt 28, serves as a means for drawing the magneto unit M away from the inductors, when stud 26 is loosened. With stud 26 loosened, the unit M is thrust inwardly until magnetic attraction draws the polar faces into contact with the inductor and cam 24 is adjusted to hold the magneto at the proper elevation. The nut 29 is then turned to pull the unit M outwardly just enough to create the very small clearance above described. The means described for effecting the radial and vertical adjustments of unit M are merely illustrative of one of various suitable means which may be used for the stated purposes.

For convenience, I have mounted the breaker point mechanism on the outside of the magneto but in such a manner that it is sheltered by the flywheel, as will be clear from Fig. 1. This location of such mechanism simplifies the character of the means used for controlling its operation, such means being carried by the flywheel *e*, or any other suitable rotary part, and herein taking the form of a roll 30. The breaker point mechanism is mounted on a plate 31, held to unit M by screws 32, which pass through slots 33 in the plate, whereby the mechanism may be bodily shifted to effect changes in the timing of the opening of the breaker points, by causing roll 30 to open them earlier or later in the revolution of crankshaft *d*, accordingly as plate 31 is moved down or up from the position shown in Fig. 3. Pate 31 has an outwardly turned part 34 to which a conducting arm 35 is secured by bolts 36. Arm 35 is suitably insulated from part 34, as indicated at 37, and carries the fixed, but adjustable, breaker point 38. The cooperating breaker point 39 is carried by one end of a lever 40, which is pivotally supported at a point intermediate its ends by a stud 41 secured to plate 31. A spring 42 tends to normally hold points 38 and 39 in contact. The other end of lever 40 is suitably shaped for engagement by roll 30 and preferably, as shown, has a tail 40′, whereby roll 30 will hold the points 38 and 39 open for a short interval. In some cases this tail may be dispensed with, especially where the installation permits time enough for the flux to build up against a closed circuited primary winding.

In this particular case, it is desired to control the speed of the engine by cutting out the ignition after the engine reaches a certain speed. For this purpose roll 30 is carried by one end of a lever 43, fulcrumed at a point intermediate its ends on a stud 44, secured to flywheel *e*. The other end of the lever is relatively heavy and is adapted to be thrown outwardly by centrifugal force but is normally restrained by a spring 45. The latter is interposed between the outer end of the lever and an adjustable abutment 46 carried by a screw 47, threaded into flywheel *e*. A lock nut 48 holds screw 47 in adjusted position. When the engine exceeds the speed, predetermined by adjustment of screw 47, arm 43 will be moved against the force exerted by spring 45 and roll 30 will be moved inwardly so as not to engage the breaker-point lever 40. A screw 49, threaded into lever 43, engages the hub *k* and limits the outward movement of roll 30.

The electrical connections are shown diagrammatically in Fig. 6 and are essentially as disclosed in the Brown & Louis patent, above identified. For example, the primary coils 12 are or may be connected in series by a wire 54 and one terminal of the primary winding is grounded as at 51. The other terminal of such winding is connected by a wire 52 to arm 35 and thus to the fixed breaker point 38. Breaker point 39 is grounded. A condenser 53 is bridged across the breaker points in the usual manner. The secondary coils are, or may be, connected in series by a wire 50 and one terminal of the secondary winding is grounded, as at 55. The other terminal of the secondary winding is connected by wire *g* to spark plug *f*.

The preferred operation of the magneto will next be described with particular reference to Figs. 2, 3, and 5. Assuming that the flux has been built up in the magnetic circuit to the desired intensity, the rotor 15, revolving in the direction of the arrow, will eventually come into the position shown in Fig. 3 and cause an effective and double break in the magnetic circuit. Both notches 18 then register with their respective polar faces 14 and there is a substantial air gap between the upper edge of each radial wall of each notch and the adjacent end edges of the polar faces 14. As set forth above, the notches are made just enough longer than the polar faces to afford gaps, such as have just been alluded to, and secure maximum effectiveness of the magnetic break. The proportions shown in Fig. 3 are those which have been found to yield the best results. At substantially the same time that this double break occurs, roll 30 engages lever 40 and causes a quick separation of the breaker 38 and 39 and an opening of the primary circuit, which has theretofore been maintained closed for the purpose of holding the flux in the magnetic circuit. On the substantially simultaneous opening of both the magnetic and the primary circuits, a very rapid decrease of flux occurs and an E. M. F. is generated in the secondary, resulting in a spark at plug *f*. The flux change, utilized for the production of the spark, is that which occurs on the breaking rather than the making of the magnetic circuit and this is important because a more rapid and more effective change of flux occurs under the former condition than under the latter.

Having described the production of the spark, the next and a most important consideration is the building up of the flux in the magnetic circuit in readiness for the production of another spark. The lever 40 preferably has its tail piece 40′ so constructed that the breaker points 38 and 39 are held separated for a short interval. This interval is preferably such as to allow the rotor 15 to move from the position shown in Fig. 3 to that shown in Fig. 5. In Fig. 5, the breaker points have just closed and in Fig. 3 they have just opened. As will be evident from Fig. 5, this interval is long enough to allow a closing of the magnetic circuit by the rotor and, in consequence, a building up of a substantial amount of flux occurs under the most favorable condition of an open circuited primary winding. Such winding does not then oppose and restrain the building up of flux and I believe that the greater part of the flux is built up during the time while the breaker points are open. While full coverage of the polar faces 14 by the inductor is not obtained, there is enough to permit the action described and my experiments indicate that results are not materially improved by delaying the closing of the breaker points beyond the time indicated. This is probably due to the fact that the completion of the building up of flux can be accomplished against the restraining influence of the short circuited primary because of the time available by the long period in which the rotor holds the magnetic circuit closed. By keeping such circuit closed as long as possible, the flux built up, while the breaker points are open, is retained and time allowed for further building up of flux, if and when the same is necessary.

There are two positions of the rotor wherein the magnetic circuit is broken in part,—one when the leading notch 18 comes into registration with the lower polar-face 14 and the other when the trailing notch 18 is similarly positioned with respect to the upper polar face. There will undoubtedly be a loss in flux at each of these two positions but such losses are kept at a minimum because the primary circuit is then closed and tends to oppose change in flux. However, the much greater intervals, when the magnetc circuit is closed, permit rebuilding up of flux to an extent to adequately compensate for such losses. It is possible to arrange the magneto, as shown at M′ in Fig. 7, so that a single notch 18′ in a somewhat wider inductor 15′ will cause a double break in the magnetic circuit by coming under both cores 10′ at the same time. This arrangement avoids ensuing losses, such as above described. However, a different disposition of the magneto on the engine is required and one which would not in many cases, admit of the compact arrangement herein shown, where the magneto fits nicely into the space between the crankcase and the flywheel and does not project materially beyond the periphery of the latter. It will be understood that the unit M′ is like the unit M except that the breaker point mechanism would need to be mounted on one of the ends faces rather than on the side face, as heretofore described.

It will be understood that the feature relating to the centrifugal arrangement for cutting out the magneto to control engine speed may be used or not, as occasion requires, and this feature is not essential in so far as the real invention is concerned.

It has been stated that the part 19 of the rotor is most important. But for this part, it would not be feasible to close the magnetic circuit before the breaker points close and thus all of the flux would have to be built up against the restraining influence of a short circuited primary winding. That is one reason why one long notch, extending from the leading end of the leading notch to the trailing end of the other notch, would not be practical at all. The other, and a most important reason for the part 19 is that it adds to the length of the period during which the magnetic circuit is closed. The effort here is to do away with as little of the periphery of the inductor as is practical, and thereby secure as long a period as is practical for the closed condition of the magnetic circuit. The present arrangement affords time for the building up of flux against a short circuited primary winding and also holds the flux that has been built up. Although a great deal of flux is built up, while the breaker points are open, as was the case in the Clark patent above referred to, much better results are obtained here, which clearly indicates the value of keeping the magnetic circuit normally closed rather than open. Also the improved results are obtained with a simple form of breaker point mechanism without going to the special provisions of the Clark patent and the complications, which as a practical matter, often arise from the use of the device therein shown.

The magneto can be operated satisfactorily in other than the exact manner described and the described operation is to be taken as illustrative of what I now believe to be the best and preferred operation, rather than in any limiting sense. The magneto installation is not so critical or sensitive that extreme care and exactitude in the adjustments of the relative positions of the parts is necessary. For example, a spark will be produced if the breaker points open earlier and before the magnetic circuit has been completely broken. The building up of flux while the breaker points are open is most desirable, important, and preferred, but it is not necessarily essential in all cases and particularly in those cases where there is a long dwell period during which the magnetic circuit is closed. In

the latter case, there may be time enough for all the flux to build up against the restraining influence of the closed circuited primary winding. However, if the inductor should have additional notches to produce more sparks per revolution, then the feature of building up flux while the breaker points are open would probably be essential for successful results.

A most important feature of the invention is that both polar faces 14 lie on the same side of the crankshaft so that by one adjustment both such faces may be moved into closely adjacent relation with the inductor. A minimum clearance between the inductor and polar faces is essential for maximum efficiency and if the polar faces were diametrically opposite such small clearances as are here used would not be feasible because the crankshaft, in many cases, does not run true enough to permit. In applying the magneto to an engine, which has been in use for some time, the wear in the bearings might be enough to defeat the use of the rubbing clearance, herein desired, unless the polar faces were both located on the same side of the shaft. Also, of course, the cores would have to be independently adjustable, if located in diametrically opposed relation and this is seldom feasible.

As distinguished from the flywheel magnetos, now found in the market, the present magneto can be made up separately from the engine and requires no special design of engine parts. In fact, a standard type of magneto, already available and of proved efficiency, can be utilized with but little modification. This one compact unit may be furnished to the engine manufacturer, with a supporting bracket therefor and the inductor, and the magneto installation can be effected without requiring any special skill. The necessity of designing the magneto to suit the engine is eliminated and an equipment is provided which is applicable to most engines without substantial change therein. It follows that the magneto can be produced at much less cost. Also, it is to be noted that the magneto can be removed by removing the one screw 26 and the complete outfit, except for the inductor (which does not require servicing) is available and accessible for servicing. The flywheel *e* has a recess, indicated at *e'* in Fig. 1, which, when turned so as to be opposite the breaker-point mechanism permits passage of the latter when the magneto unit M is removed. Such unit, containing all parts on which service can ever be required, may be removed and shipped back to the factory for repairs and another unit put in place to allow continued operation. One does not have to dismantle any part of the engine to get at the magneto.

The invention is characterized over magnetos in which the magnets rotate, in that a less amount of material, handled in a less expensive way, is productive of better results. As to that type of magneto in which the inductor rotates and the magnets are stationary, this invention points out the particular elements and arrangement thereof, which yield commercially successful results and render this type suitable where heretofore it has been unsuitable.

The invention has been disclosed herein, in an embodiment at present preferred, for illustrative purposes, but the scope of the invention is defined by the appended claims rather than by the foregoing description.

What I claim is:

1. A magneto, comprising, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; cooperating and relatively movable breaker points, a primary circuit including said primary winding and breaker points and arranged to be opened and closed by the separation or engagement of said points, a rotary inductor movable in close proximity to the polar faces of said cores to maintain a normally closed magnetic circuit and arranged periodically to break such circuit substantially simultaneously at both polar faces, both said polar faces being located on the same side of the axis of revolution of said inductor, and means for separating said breaker points at substantially the same time that the magnetic circuit is broken at both said polar faces.

2. A magneto, comprising, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; cooperating and relatively movable breaker points, a primary circuit including said primary winding and breaker points and arranged to be opened and closed by the separation or engagement of said points, a rotary inductor movable in close proximity to the polar faces of said cores to maintain a normally closed magnetic circuit and arranged periodically to break such circuit substantially simultaneously at both polar faces, both said polar faces being located on the same side of the axis of revolution of said inductor, and means for separating said breaker points at substantially the same time that the magnetic circuit is broken at both said polar faces and for holding them open until the inductor again closes such circuit.

3. A magneto, comprising, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; cooperating and relatively movable breaker points, a primary circuit including said primary winding and breaker points and arranged to be opened and

closed by the separation or engagement of said points, a rotary inductor movable in close proximity to the polar faces of said cores to maintain a normally closed magnetic circuit and arranged periodically to break such circuit substantially simultaneously at both polar faces, both said polar faces being located on the same side of the axis of revolution of said inductor, means for separating said breaker points at substantially the same time that the magnetic circuit is broken at both said polar faces, and means for moving said unit to simultaneously move both said polar faces toward and away from said inductor.

4. A magneto, comprising, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; cooperating and relatively movable breaker points, a primary circuit including said primary winding and breaker points and arranged to be opened and closed by the separation or engagement of said points, a rotary inductor movable in close proximity to the polar faces of said cores to maintain a normally closed magnetic circuit and arranged periodically to break such circuit substantially simultaneously at both polar faces, both said polar faces being located on the same side of the axis of revolution of said inductor, means for separating said breaker points at substantially the same time that the magnetic circuit is broken at both said polar faces and for holding them open until the inductor again closes such circuit, and means for moving said unit to simultaneously move both said polar faces toward and away from said inductor.

5. A magneto, comprising, a rotary inductor, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, and means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken.

6. A magneto, comprising, a rotary inductor, a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, and means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken and holding it open until the inductor moves far enough to again close the magnetic circuit.

7. A magneto, comprising, a rotary inductor; a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken, and means for adjusting said unit to simultaneously move both said polar faces toward or away from said inductor.

8. A magneto, comprising, a rotary inductor; a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions spaced apart by an angle less than 180 degrees and so as to register substanially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken and holding it open until the inductor moves far enough to again close the magnetic circuit, and means for adjusting said unit to simultaneously move both said polar faces toward or away from said inductor.

9. A magneto, comprising, a rotary inductor; a stationary unit having a source of

magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which the periphery of said inductor moves in close proximity to maintain a normally closed magnetic circuit, and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions in its periphery spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, and means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken.

10. A magneto, comprising, a rotary inductor; a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which the periphery of said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions in its periphery spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, and means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken and holding it open until the inductor moves far enough to again close the magnetic circuit.

11. A magneto, comprising, a rotary inductor; a stationary unit having a source of magnetic flux, a pair of cores connected one to each polar extremity of said source, and primary and secondary windings on said cores; said cores having polar faces with respect to which the periphery of said inductor moves in close proximity to maintain a normally closed magnetic circuit and which are located both on the same side of the axis of revolution of said inductor, said inductor having a pair of non-magnetic portions in its periphery spaced apart by an angle less than 180 degrees and so as to register substantially simultaneously one with each of said polar faces and create a double break in said circuit, a normally closed electrical circuit including said primary winding, means for opening said electrical circuit substantially at the same time that said magnetic circuit is broken and holding it open until the inductor moves far enough to again close the magnetic circuit, and means for bodily moving said unit to simultaneously move both said polar faces toward or away from the periphery of said inductor.

12. A magneto, comprising, a rotary inductor consisting of a cylindrical body having in its periphery two notches which extend parallel with the axis of the body from one end face to the other and which are spaced apart by an angle less than 180 degrees; a stationary unit comprising a straight bar permanent magnet, cores extending one from each polar extremity of said magnet toward and terminating in closely adjacent relation to the periphery of said inductor and so spaced that when one of said notches registers with one of said cores the other registers with the other core, and primary and secondary windings on both said cores; a normally closed electrical circuit including said primary winding, and means for opening said circuit substantially at the same time that both said notches register with both said cores.

13. A magneto, comprising, a rotary inductor consisting of a cylindrical body having in its periphery two notches which extend parallel with the axis of the body from one end face to the other and which are spaced apart by an angle less than 180 degrees; a stationary unit comprising a straight bar permanent magnet, cores extending one from each polar extremity of said magnet toward and terminating in closely adjacent relation to the periphery of said inductor and so spaced that when one of said notches registers with one of said cores the other registers with the other core, and primary and secondary windings on both said cores; a normally closed electrical circuit including said primary winding, and means for opening said circuit substantially at the same time that both said notches register with both said cores and for holding it open until both cores are in part covered by peripheral portions of said inductor.

14. A magneto, comprising, a rotary inductor consisting of a cylindrical body having in its periphery two notches which extend parallel with the axis of the body from one end face to the other and which are spaced apart by an angle less than 180 degrees; a stationary unit comprising a straight bar permanent magnet, cores extending one from each polar extremity of said magnet toward and terminating in closely adjacent relation to the periphery of said inductor and so spaced that when one of said notches registers with one of said cores the other registers with the other core, and primary and secondary windings on both said cores; a normally closed electrical circuit including said primary winding, means for opening said circuit substantially at the same time that both said notches register with both said cores and for holding it open until both cores are in

part covered by peripheral portions of said inductor, and means for moving said unit in a radial direction with respect to said inductor to carry said cores toward or away from the periphery thereof.

In testimony whereof I have affixed my signature.

IRA E. HENDRICKSON.

Feb. 10, 1931. F. J. HARDMAN 1,792,089

IGNITION DEVICE

Filed June 27, 1929

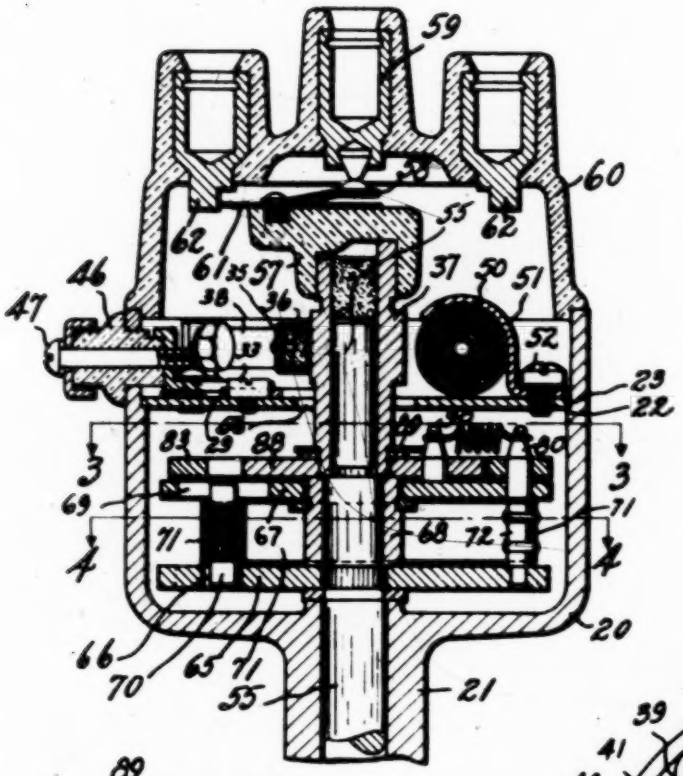

Fig. 1

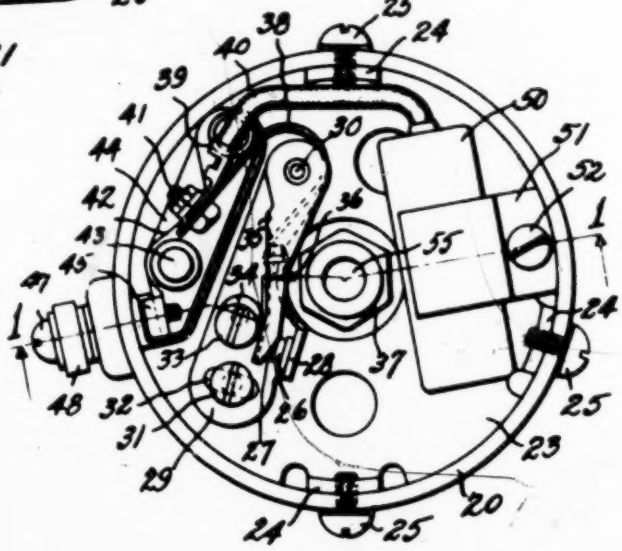

Fig. 2

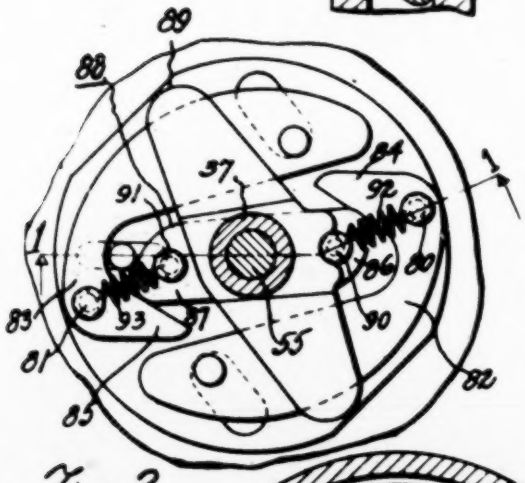

Fig. 3

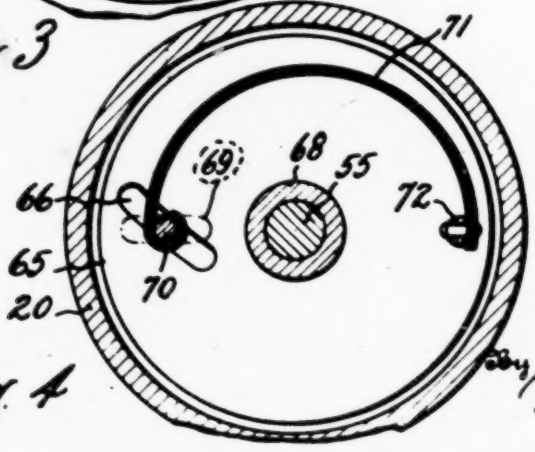

Fig. 4

Inventor

Frederick J. Hardman

by Spencer Hardman & Fehr

his Attorneys

Patented Feb. 10, 1931

1,792,089

UNITED STATES PATENT OFFICE

FREDERICK J. HARDMAN, OF DAYTON, OHIO, ASSIGNOR TO DELCO-REMY CORPORATION, OF ANDERSON, INDIANA, A CORPORATION OF DELAWARE

IGNITION DEVICE

Application filed June 27, 1929. Serial No. 374,171.

This invention relates to improvements in ignition devices for internal combustion engines.

It is among the objects of the present invention to provide an ignition device adapted automatically to vary the time of sparking impulses for the engine in accordance with variations in temperature conditions, or in accordance with both variations in engine speed and temperature conditions.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a vertical sectional view taken through the center of the ignition device, and on lines 1—1 of Figs. 2 and 3, certain parts being shown in elevation for the sake of clearness.

Fig. 2 is a plan view of the ignition device with the distributor head removed.

Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1.

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1.

Referring to the drawings, the ignition device is shown comprising a cup-shaped housing 20 having a cylindrical boss 21 extending therefrom by which the ignition device may be supported upon the engine, not shown. Within the housing 20 there is provided an annular shoulder 22 upon which is supported a plate 23, said plate having a plurality of upturned ears 24 provided with screw-threaded openings for receiving the screws 25 which extend through the annular wall of the housing 20, enter the screw-threaded openings in the ears 24 of plate 23 and securely attach said plate 23 within the housing 20. The plate 23 supports the circuit interrupting mechanism of the ignition device, said circuit interrupting mechanism comprising a stationary contact 26 and a movable contact 27. The stationary contact 26 is carried by an up-turned ear 28 provided by the bracket 29 which is pivotally secured to a pin 30 supported by the plate 23. The bracket is adjustable for purposes to be described, a screw 31 extending through an elongated slot 32 in the bracket, screw-threadedly engaging the plate 23 so as to clamp the bracket 29 upon said plate. The elongated slot 32 has its longer sides substantially coaxial of the pivot pin 30 whereby the bracket may be swung about said pivot pin for adjustment purposes when the screw 31 is loosed.

In order to obtain delicate adjustments of the bracket 29, a member 33 is provided, having a stud portion rotatably attached to the plate 23 and a head portion eccentric to the stud portion, said head portion fitting into an elongated slot 34 in the bracket, the longer sides of said slot 34 being substantially radial of the pivot pin 30. From this it may be seen that the bracket 29, when screw 31 is loosed, may be adjusted about the pivot pin 30 by the rotation of the eccentric head of member 33.

The movable contact 27 is carried by the contact arm or lever 35 which is pivotally supported by the pin 30 and insulated therefrom in any suitable manner, the contact 27 being supported at the outer end of said lever. Intermediate the contact 27 and the pivot pin 30, lever 35 has a rubbing block 36 which is adapted to be engaged by the cam 37 so as to move the lever 35 to disengage the contact 27 from the stationary contact 26. A rivet which holds the rubbing block 36 to the arm 35 also anchors one end of the spring conductor 38 to said arm 35, the other end of said spring conductor being secured with clip 39 of the lead 40 to an angular ear 41 provided on the terminal plate 42. Terminal plate 42 is secured to plate 23 by rivets 43, said plate, however, being insulated from the plate 23 by the insulating plate 44. An upright angular ear 45 provided on the terminal plate 42 engages the insulator 46 which extends through an opening in the annular wall of the housing 20 and supports the connecting screw 47 to the outer end of which the terminal clip 48 is attached. The lead 40 connects one foil of the condenser 50 with the movable contact 27, the other foil of said condenser being grounded to the plate 23 by

the bracket 51 which is secured to the plate 23 by screws 52, said bracket being thus electrically connected with the stationary contact 26.

The drive shaft of the ignition device is rotatably supported in the cylindrical boss 21, said drive shaft being designated by the numeral 55. The drive shaft extends through a central opening 56 in the plate 23, the cam 37 being rotatably mounted upon the portion of the drive shaft which extends through said opening. The upper end of the cam 37 supports the rotor 57 which has a spring conductor 58 electrically engaging the central high tension terminal 59 of the distributor head 60, another terminal plate 61 supported by the rotor 57 being adapted to be moved into juxtaposition of the various terminal posts 62, supported by the distributor head 60 by the rotation of the rotor 57. Terminal posts 62 are adapted to be connected to the various cylinders of the internal combustion engine with which the present device is to be used. The distributor head rests upon the upper edge of the housing 20 and is secured to said housing in any suitable manner.

Within the housing 20 a plate or disc 65 is secured to the drive shaft 55 so that it will be rotated therewith. An elongated slot 66 is provided in the disc 65 adjacent the outer peripheral edge thereof, said slot being angularly arranged relative to a plane radial of the drive shaft. This angular slot 66 is clearly illustrated in the Fig. 4. An intermediate member, designated by the numeral 67, in the form of a disc similar to the disc 65, is secured to a sleeve 68 which forms a bearing by which the intermediate member 67 is rotatably supported by the drive shaft 55. This sleeve 68 rests upon the disc 65 whereby the intermediate member 67 is held in proper spaced relation relative to said disc 65. The intermediate member 67 has an elongated slot 69 arranged substantially radially of the bearing sleeve 68, the length of this slot 69 being substantially equal to the length of the angular slot 66. A pin 70 has one end extending into the angular slot 66 of the plate 65, the other end of said pin extends into the radial slot 69 of the intermediate member 67. One end of a temperature responsive element or thermostatic, bimetallic strip 71, is securely anchored to the pin 70, the other end of said thermostat 71 being secured to a post 72 which is carried by the disc 65. The thermostat 71 is so constructed that, at decreasing temperatures it will expand to move the pin 70 outwardly away from the axis of the drive shaft 55 whereby the pin will follow the angular slot 66, said movement of the pin causing the intermediate member 67 to be rotated clockwise relative to the disc 65 as regards the Figs. 2 and 4, which rotation of the intermediate member 67 is in the direction of rotation of cam 37. Thus, at decreasing temperatures the thermostat 71 will expand and clockwise vary the angular relation between the intermediate element 67 and the disc 65. At increasing temperatures the element 71 will contract, follow the path of the angular slot 66 of disc 65 toward the axis of the shaft 55 whereby a counter-clockwise rotative motion is transmitted to the intermediate member 67 or more specifically a rotative motion in a direction opposite to the rotation of cam 37.

The intermediate member 67 has two posts 80 and 81 supported thereon which pivotally support centrifugal weight members 82 and 83 respectively. These weight members each have camming arms 84 and 85 respectively, which are adapted to engage the ends 86 and 87 respectively, of the plate 88 which is secured to the lower end of the cam 37 so as to be rotatable therewith. A retainer plate 89 maintains the centrifugal weight members 82 and 83 in proper position, said retainer plate being carried on the lower end of the cam 37. The arms 86 and 87 of plate 88 are provided with studs 90 and 91 respectively. Between the post 80 and stud 90 a spring 92 is anchored and between the post 81 and stud 91 a spring 93 is supported both springs 92 and 93 yieldably urging the plate 87 so that it will exert pressure upon the respective camming arms 84 and 85 of the centrifugal members 82 and 83 respectively, whereby said members or weights are yieldably urged toward the normal position, or more specifically toward the axis of the drive shaft 55. From this it may be seen that the intermediate member 67 is connected with the cam 37 through the posts 80 and 81, centrifugal weight members 82 and 83 and plate 88, said plate having arms 86 and 87 engaged by the centrifugal weight members 82 and 83 respectively. The plate 88, as has been mentioned, is attached to the cam 37. Thus, the cam 37 will be rotated with the intermediate member 67.

A proper increase in speed will cause the weights 82 and 83 to fly outwardly, exerting pressure upon the arms 86 and 87 of the plate 88 to rotate said plate clockwise as regards Fig. 3, thus causing the plate 88 to rotate the cam 37 clockwise in addition to the clockwise rotation of the cam by the engine. Thus, at increasing speeds, by the added clockwise rotation of the cam, the time of sparking impulses is automatically advanced in accordance with increases in engine speed and inversely as the weights are drawn inwardly by springs 92 and 93 at reduced engine speeds the time of sparking impulse will be retarded due to the counter-clockwise movement of the cam by the plate 88.

The movement of the thermostatic member 71 outwardly, at lowering temperatures,

and inwardly at rising temperatures, will move the intermediate member 67 clockwise and counter-clockwise respectively, said rotation being transmitted through the speed responsive means to the cam 37 and thus the cam will be rotated clockwise or counter-clockwise respectively, to advance or retard the spark in accordance with such respective decreases or increases in temperature conditions.

It has been found by experience that at comparatively low temperatures an internal combustion engine is more easily started if the time of sparking impulses is set substantially in advance to the setting for normal temperatures so that the thermostatic element in this instance will operate at lowering temperatures to advance the spark and thus facilitate starting of the engine. At normal temperatures the thermostat will maintain pin 70 substantially midway between the ends of slots 66 and 69 so that at lowering temperatures the pin may move toward the clockwise rotation ends of said slots, while at increasing temperatures where a more retarded spark will more efficiently fire the engine, the pin 70 will approach the counterclockwise rotation end of said slots.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An ignition device for an internal combustion engine comprising in combination; a circuit interrrupter; a shaft adapted to be driven by the engine; a cam for operating said circuit interrupter, rotatably supported upon the said shaft; a speed responsive device rotatably supported by said shaft and connected to the cam; a member attached to the shaft; means connected between the speed responsive device and said member for connecting said device to the shaft, said means being movable to adjust the angular relation between said device and member; and a thermostat directly connected with said aforementioned means for operating it to obtain said angular adjustment in accordance with temperature changes.

2. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a cam member for operating said interrupter; a shaft member; plates carried by the shaft in superposed relation, one being rotatable relative to said shaft; a speed responsive device carried by the plate rotatable relative to said shaft, said speed responsive means being connected with the cam to adjust the cam in accordance with the speed of the plate supporting said device; a member connecting the plates whereby the plate carrying the speed responsive device is connected with the shaft, said member being movable relative to said plates to adjust the one relative to the other angularly; and a temperature responsive device attached to the plate secured to the shaft and to the said member for moving said member to secure adjustments of the plates in response to temperature changes and independently of ignition device operation.

3. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a drive shaft adapted to be driven by the engine; a cam for operating said circuit interrupter, said cam being rotatably supported upon the shaft; an intermediate member rotatably supported by the shaft; speed responsive means carried by the intermediate member and connected with the cam; a supporting element carried by and secured to the shaft; and temperature responsive means for connecting the intermediate member and the supporting element and for varying the angular relation between them in accordance with temperature changes.

4. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a drive shaft adapted to be driven by the engine; a cam for operating said circuit interrupter, said cam being rotatably supported upon the shaft; a mounting plate carried by and secured to the shaft; an intermediate member rotatably supported by the shaft; temperature responsive means mounted on the mounting plate and connecting the said mounting plate and the intermediate member, said means being adapted to vary the angular relation between them in accordance with temperature changes; a speed responsive means carried by the intermediate member for connecting said member with the cam and for varying the angular relation between the shaft and cam in accordance with variations in the speed of the shaft.

5. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a cam for operating said interrupter; a drive shaft; a plate drivingly connected with the cam; said plate having an elongated slot; a disc secured to the drive shaft, and having an elongated slot arranged angularly to the slot in the plate; a pin extending into both slots; and a temperature responsive element anchored at one end to the disc and at the other end to said pin for moving the pin to rotate the plate relative to the disc in response to temperature variations.

6. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a drive shaft; a cam for operating said interrupter, rotatably carried by the drive shaft; a plate rotatably supported by the drive shaft and operatively connected with the cam; said plate having an elongated slot; a disc secured to the drive

shaft, having an elongated slot arranged angularly relative to the slot in the plate; a pin extending into both slots; and a bimetallic strip, anchored at one end to the disc and at the other end to the pin for operating said pin to rotate the plate relative to the disc.

7. An ignition device for an internal combustion engine comprising in combination, a circuit interrupter; a drive shaft; a cam for operating said circuit interrupter, rotatably supported by the shaft; a plate rotatably carried by the shaft and having an elongated slot; speed responsive means carried by the plate and operatively engaging the cam for varying the angular relation between the cam and shaft in response to variations in the speed of the shaft; a disc secured to the shaft, having an elongated slot angularly arranged relative to the slot in the plate; a pin extending into both slots; and a bimetallic element anchored at one end to the disc and at the other end to the pin and adapted to operate the pin for rotating the plate relative to the disc whereby the angular relation between the cam and shaft is varied in accordance with temperature variations.

In testimony whereof I hereto affix my signature.

FREDERICK J. HARDMAN.

April 18, 1933. K. A. HARMON 1,904,308

MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 1

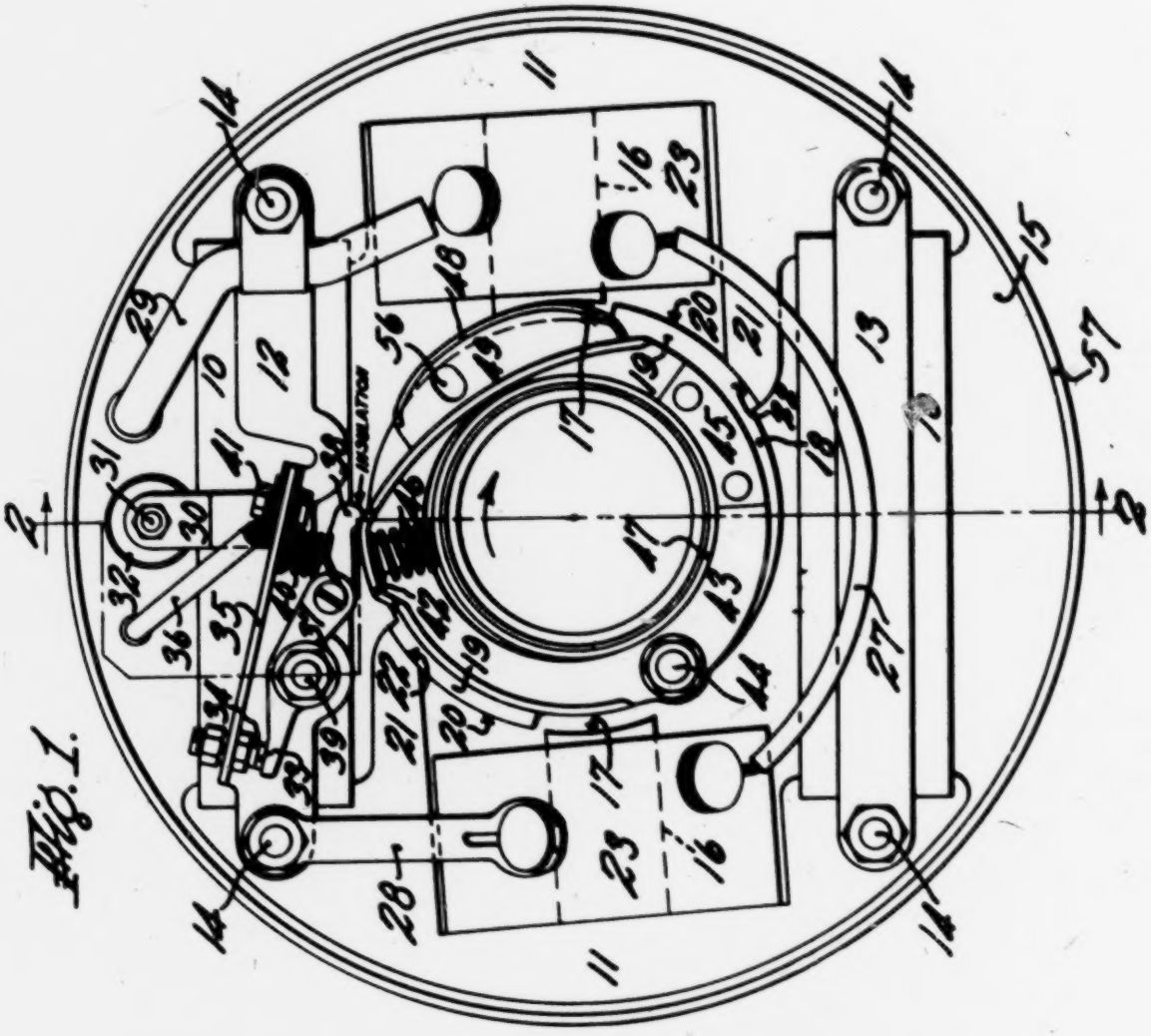

Fig. 1.

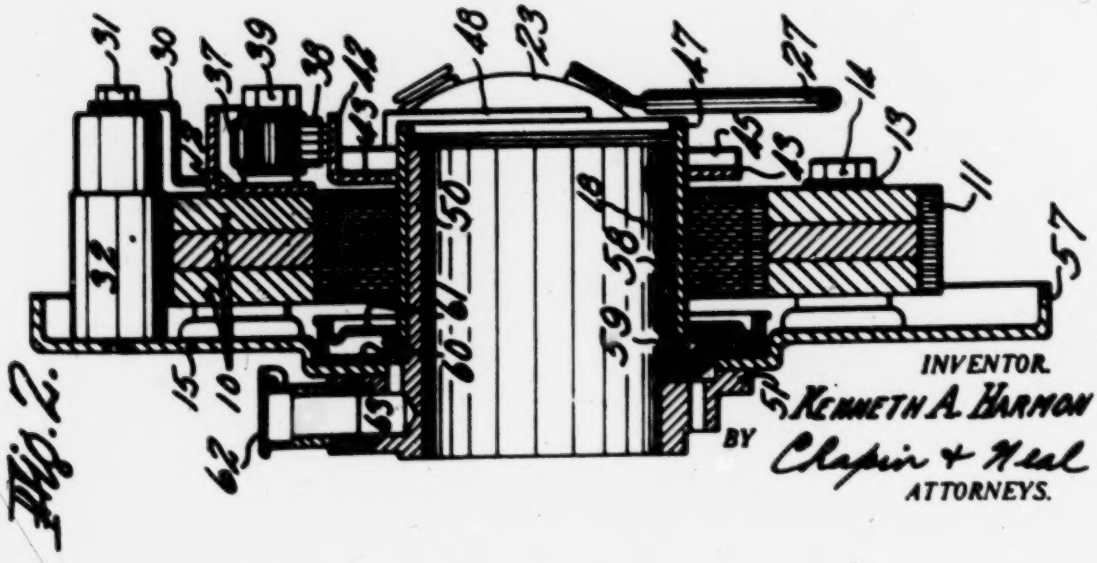

Fig. 2.

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April 18, 1933. K. A. HARMON 1,904,308

MAGNETO

Original Filed Oct. 6, 1931 4 Sheets-Sheet 2

Fig. 3.

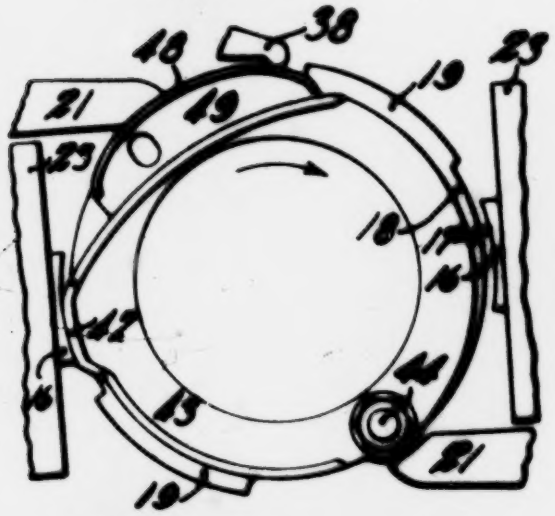


Fig. 4.

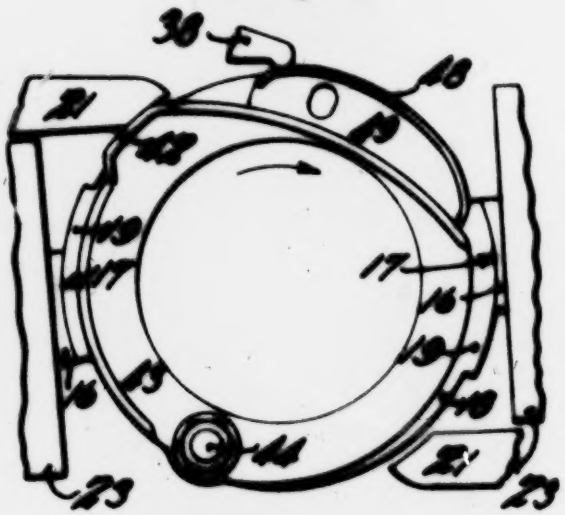


Fig. 5.

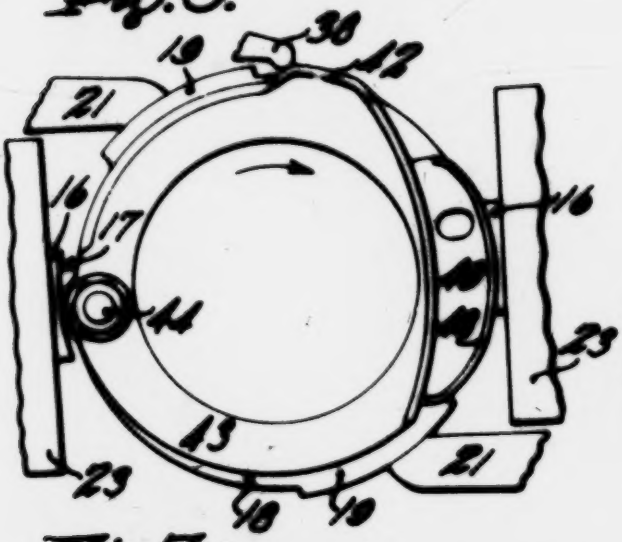


Fig. 6.

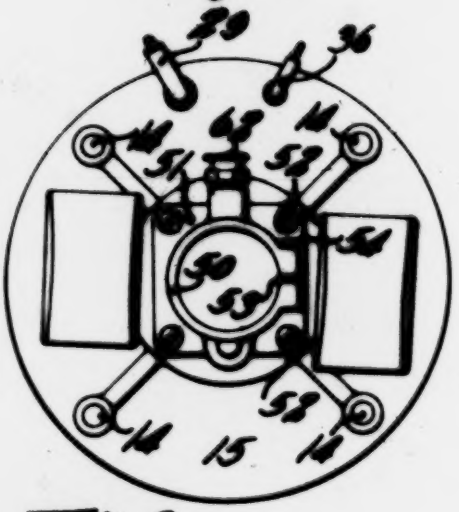


Fig. 7.

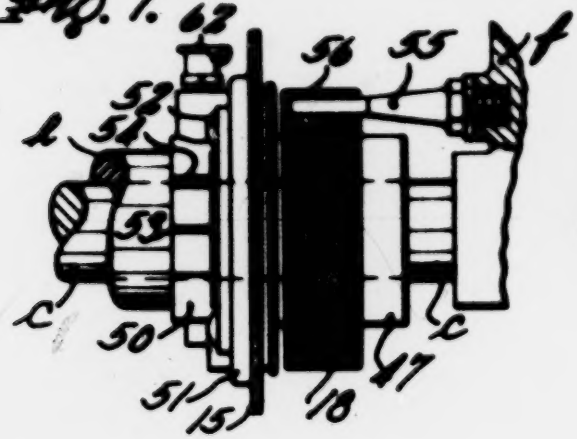
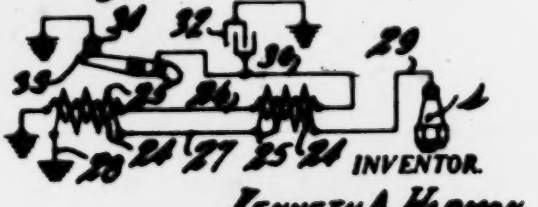


Fig. 8.



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MAGNETO

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Fig. 9.

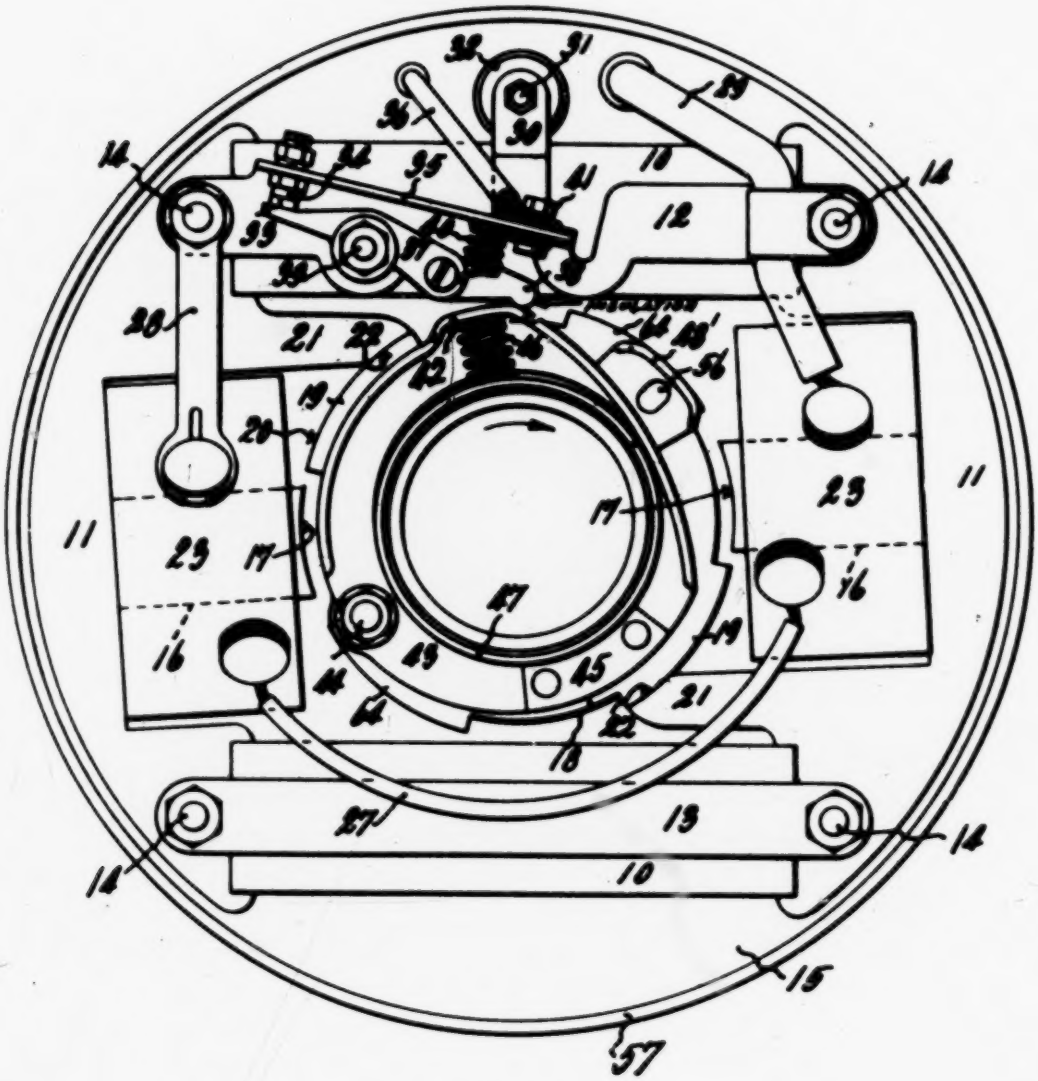

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Fig. 10.

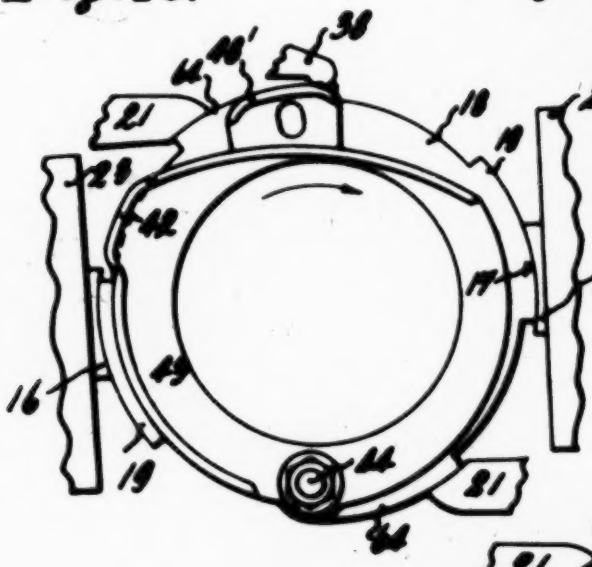


Fig. 13.

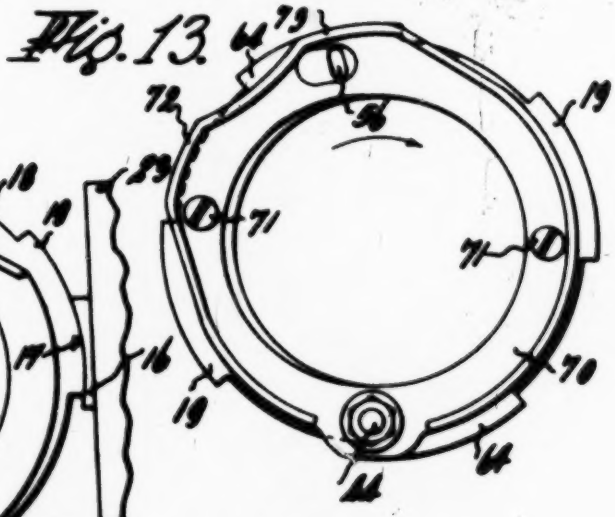


Fig. 11.

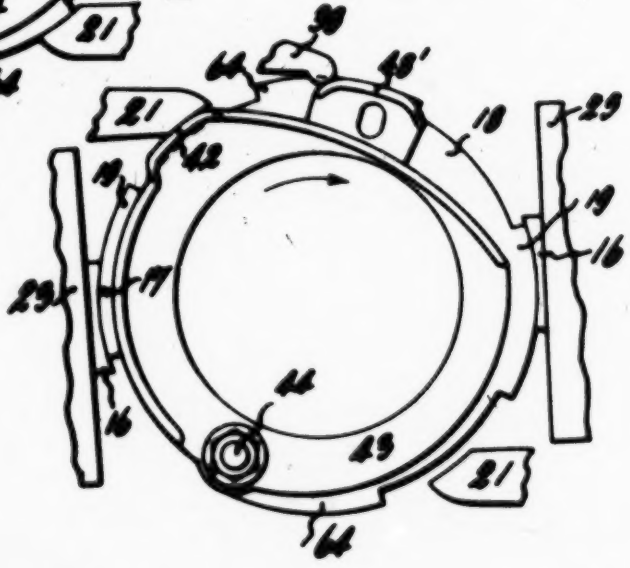
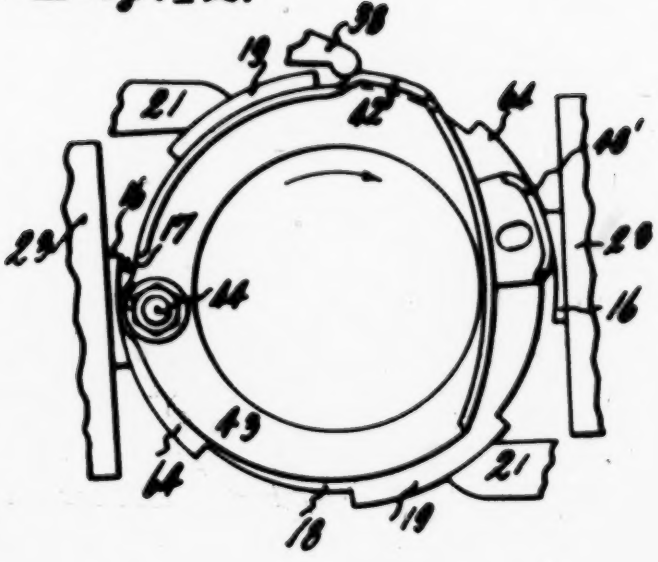


Fig. 12.



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UNITED STATES PATENT OFFICE

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MAGNETO

Application filed October 6, 1931, Serial No. 567,171. Renewed May 27, 1932.

This invention relates to improvements in magnetos of the rotary inductor type.

The inductor, of magnetic material and usually of the unwound type, is notched or has non-magnetic portions in its periphery and the remaining unnotched portions form magnetic projections which cooperate with two pole pieces, connected one to each polar extremity of a suitable magnetic source, such as a permanent magnet, for example. These projections are adapted during part of each revolution of the inductor to interconnect the two pole pieces and establish a magnetic circuit from said source through the pole pieces and inductor. When the notched portions of the inductor lie adjacent the pole pieces, this magnetic circuit is broken. Primary and secondary windings are applied to some part of such circuit, usually to at least one and preferably both of the pole pieces. The primary circuit, in accordance with usual practice, is in a normally closed electrical circuit, the opening and closing of which is controlled by a pair of relatively movable breaker points, the operation of which is controlled by suitable means, such as a cam, usually carried by or at least movable with the inductor.

The problem of this invention is to improve the efficiency of such a magneto. This has been effected primarily by the provision of an additional means, preferably independent of the usual means, for operating the breaker points. An additional opening and closing of the primary circuit is effected with the advantages set forth below.

If the magneto is operated with a normally closed primary circuit, flux builds up relatively slowly in the magnetic circuit. Considerable time is required for the purpose. The magnetic projections have to be relatively long in peripheral extent in order to maintain the pole pieces interconnected for a sufficient length of time to build up the necessary amount of flux against the restraining influence of a short circuit primary winding. By my invention, a magneto operating according to such plan, is improved by the extra opening and closing of the breaker points. They are made to open as the inductor moves into position to "make" the magnetic circuit and are held open for a substantial interval to allow flux to build up as rapidly and completely as possible in the magnetic circuit. They are closed before the inductor breaks this circuit in order to hold the flux against substantial diminution until the inductor has moved into an "optimum" position for the break, i. e., one in which a substantial double air gap exists between the magnetic projections and the pole pieces. Then the breaker points are again opened by the usual mechanism to release the flux and cause a sudden change in the magnetic circuit through the windings.

The action may be, and preferably is, aided and improved by the provision of extensions, one from each pole piece, with which the rotor projections cooperate to make a shunt circuit from the magnetic source in a low reluctance path lying wholly outside the windings. Thus shunt circuit is made just prior to the break of the magnetic circuit and to the spark-producing opening of the breaker points. Accordingly, the decrease in flux in the main magnetic circuit through the windings is accelerated by the provision of the shunt circuit, which affords a better path for the flux and thereby diverts it from the main circuit.

In the magneto above described, there are at least two positions of the inductor during each revolution thereof in which the magnetic circuit is made and broken. There may to advantage be more than two such positions, as will later appear. In many cases, only one of these positions is utilized for the production of a spark. The other position or positions, however, has or have spark producing possibilities, and if the breaker points are open while the inductor moves into and through any other position, a spark may be produced which is bothersome because it occurs at an undesired time. This extra spark is not so effective but it is often substantial enough to cause trouble. My invention enables the suppression of this undesired spark. It enables the primary circuit to be maintained closed, while the inductor travels

through all but a selected one of its two or more ranges, in which the magnetic circuit is made and subsequently broken, and thus the closed circuited primary winding is effective to restrain a substantial flux change in the circuit. Yet, when the inductor enters the selected one of its ranges, the restraining influence is removed by the additional opening of the breaker points, enabling flux to build up rapidly and effectively.

Other objects and advantages will appear as the detailed description proceeds and will be pointed out in the appended claims.

The invention will be disclosed for illustrative purposes with reference to the accompanying drawings, in which:

Fig. 1 is a front elevational view of a magneto embodying my invention;

Fig. 2 is a sectional view thereof taken on the line 2—2 of Fig. 1;

Figs. 3, 4 and 5 are diagrammatical views, illustrative of the operation of the magneto and particularly of the times of opening and closing of the breaker points with relation to the position of the rotor;

Fig. 6 is a small-scale rear elevational view of the magneto;

Fig. 7 is a fragmentary side elevational view showing the manner of mounting the magneto on and driving it from an engine;

Fig. 8 is a diagrammatical view illustrative of the electrical connections of the magneto;

Fig. 9 is a view taken similarly to Fig. 1 but showing a modification of the invention,—a rotor with four projections;

Figs. 10, 11 and 12 are views showing the rotor of Fig. 9 in three different positions which correspond to the positions shown in Figs. 3, 4 and 5 in connection with the rotor of Fig. 1; and

Fig. 13 is an elevational view of the rotor equipped with a modified form of cam for operating the breaker points.

Referring to these drawings; the magneto includes a source of magnetic flux,—such as the permanent magnets 10,—and, as illustrated, the magnets of the source are arranged in two spaced parallel groups. Like ends of the magnets in these two groups are interconnected by members 11 (Fig. 1) made up of soft iron laminations. The ends of the magnets tightly fit in recesses in the members 11. These members are tied together by bars 12 and 13 of non-magnetic material and the assembly is secured by cap screws 14 to a circular supporting plate 15 of non-magnetic material. The cap screws 14, which pass through the laminated members 11, serve to bind the cross bars to the members 11 and the latter to plate 15 (Fig. 2). The laminated members 11 have extensions 16 (Fig. 1), forming cores which project from their respective members toward one another and terminate with curved polar faces 17. An unwound inductor 18, made up of soft iron laminations, rotates between these faces and has two substantially diametrically opposed projections 19, having faces 20 curved concentrically with the faces 17 and of a diameter only slightly less than the distance between the faces 17. Intermediate these projections, the periphery of the rotor is of less diameter to create, when positioned as shown, a double break in the magnetic circuit from said source through the cores 16. When the rotor moves into such position that the projections 19 interconnect the cores as shown in Fig. 4, the aforesaid magnetic circuit is established.

In addition to providing for the aforesaid break in the magnetic circuit to periodically cause decrease in flux through said cores, means are provided for shunting the magnets to cause a more rapid and more effectual decrease in flux through the cores by diverting it through a path of low reluctance. For this purpose, each member 11 has an extension 21 to cooperate with the projections 19 of the rotor. One of these extensions lies above one core 16 and the other below the other core 16 and the two have polar faces 22, which are arranged substantially in diametrically opposed relation and are curved concentrically with the faces 17 and 20. When the rotor is positioned as in Fig. 1, the two extensions 21 are interconnected by the rotor 18 and these elements afford a low reluctance shunting path for the flux from the magnets. Flow of flux through cores 11 is effectually diverted.

The magneto also includes primary and secondary windings on the cores 16. On each is a coil case 23, which contains a primary coil 24 and a secondary coil 25. These coils are shown diagrammatically in Fig. 8. As shown for illustrative purposes, the two primary coils and the two secondary coils are connected in series, as by wires 26 and 27, respectively. One terminal of the primary winding and one terminal of the secondary winding is grounded, as indicated. The secondary ground wire is shown at 28 in Fig. 1 as being connected to the cross bar 12 and clamped thereto by cap screw 14. The other terminal of the secondary winding is adapted to be connected by a wire 29 to the ignition system and directly or indirectly to a spark plug *s*. The other terminal of the primary winding is connected by a wire 30 to one terminal 31 of a condenser 32 and to an insulated and movable breaker point 33. The cooperating and fixed breaker point 34 is grounded by being connected directly to a flange 35 on cross bar 12 (Fig. 1). The other terminal of condenser 32 is also grounded, being connected as shown in Fig. 2 to plate 15. The wire 36, in Figs. 1 and 6, is adapted for connection, if desired, to a ground switch (not shown) by which the normally insulated terminal of the primary winding may be grounded.

The breaker point mechanism includes a lever, comprising a metallic portion 37 (Figs. 1 and 2), of inverted U-shape section, and a portion 38 of insulating material. This lever is pivotally mounted on and insulated from a stud 39, carried by cross bar 12. Breaker point 33 is fixed to the metallic portion 37 of this lever and such portion is electrically connected by means of a spring 40 and bolt 41 to the conductor 30,—the bolt passing through flange 35 but being insulated therefrom as are also the spring 40 and conductor 30. The spring 40 also serves to hold the breaker points in engagement. For the purpose of separating the breaker points, a cam 42 carried by the rotor is employed. As shown, this cam is a flange-like extension of a ring 43, which is pivotally connected to the rotor by a stud 44 and carries a weight 45. A spring 46 acts between a sleeve 47 (to which the rotor is fixed) and cam 42 tending to force it radially outward and swing ring 43 on its pivot 44. Such motion is limited by the engagement of the lower part of the inner periphery of ring 43 with sleeve 47. The arrangement constitutes a governor-operated cam. When the rotor reaches a predetermined speed, the weight 45 will move outwardly by centrifugal force, overcoming the force of spring 46 and drawing cam 42 inwardly out of the path of the end of the breaker point lever 38. If the "hit or miss" ignition is not desired, the ring 43 may be clamped to the rotor so as not to turn independently thereof.

In addition to the above cam, whether it be of the centrifugally-operated or fixed type, there is provided an auxiliary cam 48, which enables an additional opening and closing of the breaker points 33 and 34 and effects certain advantages, which will hereinafter be pointed out in connection with the operation of the magneto. This auxiliary cam constitutes one of the main features of my invention. It consists of a flange formed on a plate 49 fixed to an end face of the rotor. It is preferably independent of the other cam, so that in cases where "hit or miss" ignition is employed, it does not have to partake of the movement of, or be effected by, the centrifugally actuated cam.

The rotor 18 is, as described, fixed to a sleeve-like shaft 47 and the latter is journalled on a hollow stud 50 (Fig. 2) which has a flange 51 (Fig. 6) secured by cap screws 52 to plate 15. One end of stud 50 is split, as at 53, and the split parts may be drawn together by a cap screw 54. This stud is adapted to be clamped in various positions of angular adjustment to a suitable support, such as a cylindrical hub *h* (Fig. 7) which is partly telescoped in the stud and which may be assumed to be a hub on the crank case of an internal combustion engine. Through this hub, the engine crankshaft *c* passes for connection to the flywheel, indicated in part at *f*. The crankshaft passes freely through stud 50 with ample clearance. The driving connection with the rotor may be effected by a stud 55 fixed to the inner face of the flywheel, extending toward the rotor, and into a hole 56 therein. As shown in Fig. 7, there is radial freedom for the stud 55 to move in hole 56 and, should the flywheel not run true, its irregularities of movement will not be communicated to the rotor. The latter has its own bearing, on which it turns truly, and the driving of it from the crankshaft is effected in the described, or any other equivalent way, which will prevent the rotor from partaking of any irregularities in the running of the crankshaft.

The plate 15 has a circular flange 57 (Fig. 1) extending toward the flywheel and adapted, although not shown, to cooperate therewith to enclose the working parts of the magneto in the usual and well understood way.

Lubrication for the rotor is provided by a wick 58 (Fig. 2) extending from an oil reservoir 59 upwardly into stud 50 and axially along the same in a slot formed therein. Part of the wick rests directly against the rotor shaft 47. The reservoir 59 is formed between two pressed metal pieces 60 and 61, the former being suitably attached to plate 15 and the latter have a tight fit in piece 60. Oil may be supplied to the reservoir through an oil cup 62 by way of a passage 63.

The operation of the magneto will next be described. It will be noted that there are two positions of the rotor in each revolution thereof when the cores 16 are interconnected. The rotor may be utilized, in either or both of these positions, to build up flux through cores 16, preparatory to the subsequent production of a spark by effecting a sudden decrease of flux through the cores. As shown, a spark is produced in only one of these positions and it is particularly desired and one of the problems of this invention to prevent the production of any substantial spark, when the rotor is in the other position. Fig. 1 shows the rotor in the position which it occupies just prior to the production of the spark. A slight additional clockwise movement of the rotor will cause cam 42 to separate the breaker points 33 and 34 and create a spark. If the breaker points 33 and 34 were allowed to remain open during the next time when the rotor projections interconnect the cores 16, a change of flux would occur in the cores and a spark would be created. This spark would not be so effective as the one produced on the preceding interconnection of the cores by the rotor but it would be substantial enough to cause trouble by its occurrence at an undesired time. To kill this undesired and so-called "maverick"

spark, the breaker points might be maintained closed except at the desired sparking time. Such a plan would restrain a change in flux through the cores at the undesired time due to the choking influence of the short circuited primary winding and would hold the flux change down to such limits that no substantial spark would be produced. But such plan also means that the flux change through the cores 16 at the desired time is also restrained. Flux has to be built up against the opposing influence of the short circuited primary winding and the change takes place slowly. While this can be done, if the cores are interconnected by the rotor for a sufficiently long time interval, it is far more desirable to permit flux to build up in cores 16 while the breaker points are open so that the change takes place as rapidly as possible without any restraining influence.

With the above considerations in mind, the plan adopted is a compromise between the two plans above outlined. It combines the advantages of both plans and eliminates the disadvantages. The cam 42 is the sort which would be used where the plan is to maintain the breaker points closed except at the one sparking time during each revolution of the rotor. Consequently, the advantage of killing the "maverick" spark will be obtained. But this cam is supplemented by the auxiliary cam 48, the purpose of which is to open the breaker points and thereby remove the restraining influence of the short circuited primary winding, as the rotor moves into position to interconnect the cores 16 just prior to the sparking time. Thus the flux is allowed to build up rapidly in cores 16 while the primary circuit is open. The action of the auxiliary cam can best be visualized from a consideration of Figs. 3 and 4. Fig. 3 shows the rotor projections 19 approaching the cores 16 to interconnect them and the auxiliary cam 48 as about to move the breaker point lever to open the breaker points. The cam 48, having opened the breaker points, maintains them open while the projections 19 swing into position to interconnect the cores and during an additional period, viz. up to the point shown in Fig. 4. During all of the period while the projections 19 fully cover the faces 17 of cores 16, the breaker points are held open to facilitate the establishment, as rapidly and completely as possible, of magnetic flux in the cores. The breaker points close at about the position of the rotor shown in Fig. 4. This enables the flux, built up in the cores as described, to be held by the closed circuited primary winding until the rotor has moved to the most effective position for the release of the flux. Such position is shown in Fig. 1. The rotor projections 19 are then separated from cores 16 by substantial air gaps and are engaged with projections 21 to shunt the flux from the magnets in a low reluctance path lying wholly outside the cores. Hence, when the breaker points separate, the restraining influence of the short circuited primary winding is removed and, in addition, a better path is afforded for the flux by way of the shunt extensions 21. As a consequence, an exceedingly rapid decrease in flux occurs, due to the combined effects of the optimum position of the rotor and the low reluctance shunt path. An exceedingly effective spark results when the breaker points separate.

Shortly following the projection of the spark, the rotor moves into the position in Fig. 5, in which the breaker points close and remain closed until again opened by cam 48. Particularly, they remain closed during the next succeeding interval when the rotor interconnects the cores for the purpose of killing the maverick spark, which would otherwise be created at a point in the movement of the rotor spaced about 180 degrees from the point at which the desired spark is created.

As above alluded to, the invention is not necessarily restricted in all its features to a rotor having only two projections. There may be more than two such projections and the invention is concerned with a magneto rotor which has at least two projections and may have more. For example, in Fig. 9 a rotor is shown having four projections and there is an advantage accruing from the use of the additional projections in that the magnets are never entirely open circuited. There is always available some low reluctance path for the magnetic flux. There are four ranges of travel of the rotor during each revolution thereof, in which the cores 16 are magnetically interconnected to afford a path for the magnetic flux. There are four other ranges of travel of the rotor during each revolution thereof, in which the shunt projections 21 are interconnected by the magnetic rotor to afford an alternative path for the flux; and the first-named and second-named ranges overlap so that there is never a time when the magnets are open circuited and without a path of low reluctance. The flux from the magnets alternately passes through the cores 16 and through the projections 21, first through one and then through the other. And the path through cores 16 is not broken until the path through projections 21 is established and the last named path is not broken until the path through the cores is again established. This results in markedly improved efficiency and is the preferred arrangement.

The arrangement of Fig. 9 differs from Fig. 1 only by the addition of the rotor projections 64, of the same size and shape as the projections 19 but disposed at right angles thereto. The auxiliary cam 48 has been

changed slightly and is designated 48'. All other parts are marked with the same reference numerals as used in Figs. 1 to 8.

The operation of the magneto shown in Fig. 9 is essentially no different from that shown in Fig. 1 except for the addition of the four additional paths for the magnetic flux which are afforded by the addition of the two projections 64. A spark is produced at only one of the four positions in which the cores 16 are interconnected although, as above noted, more than one spark per revolution may be produced. The production of a spark at the other positions is prevented. Tracing the operation in detail, Fig. 9 shows the rotor in the position which it occupies just prior to the production of the spark. A slight additional clockwise movement of the rotor will cause cam 42 to separate the breaker points 33 and 34 and produce a spark. The rotor projections 19 have moved far enough away from cores 16 to create an effective air gap and to make an alternative shunt circuit through projections 21. While this has been happening, the flux built up in cores 16, while projections 19 were interconnecting the same, has been held by the closed circuited primary winding. On an opening of the breaker points, this flux will be released and rapidly and practically instantaneously die out of cores 16 because of the other and better path available through projections 21. The rotor projections 64 are not functioning at this time. Shortly after the production of the spark, the rotor assumes the position shown in Fig. 12, in which the breaker points close and remain closed for a substantial interval. The projections 19 are then interconnecting the shunt projections 21 and the projections 64 have moved part way into the position in which they interconnect cores 16. There will be but a comparatively small flux change in the cores because the shunt circuit through projections 21 has not yet been broken. On continued rotation, the projections 19 leave the shunt projections and the shunt magnetic circuit is broken but the projections 64 have already established an alternative circuit through cores 16, thus avoiding open circuiting of the magnets. During all of the time while the projections 64 are travelling adjacent cores 16, the primary circuit is closed and no spark is therefore produced. The projections 64 next move into range to interconnect the shunt projections 21 but before they leave cores 16, the projections 21 will have been interconnected by projections 19. The primary circuit is still closed and maintained so during all the range of travel of projections 19 in interconnecting relation with cores 16. Continued movement of the rotor will carry the projections 19 away from the cores 16 but not until they have come into interconnecting relation with shunt projections 21. Then, when the projections 19 swing away from projections 21, the projections 64 will again have moved into interconnecting relation with cores 16. Then the projections 64 move out of connecting relation with cores 16 but not until they have moved into such relation with shunt projections 21. During all this time the breaker points remain closed and no spark is produced by the shiftings of the magnetic circuit described. The rotor now occupies the position shown in Fig. 10. The projections 19 are moving into connecting relation with the cores 16 and the projections 64 are moving out of such relation with projections 21. The breaker points will be opened by the auxiliary cam 48' and some flux will build up in cores 16 but there still exists the shunt path through projections 21 and the flux will not build up completely until projections 64 leave projections 21, which occurs before the breaker points again close. Immediately the shunt path is broken, the flux builds up almost instantaneously in cores 16 due to the open primary circuit. The breaker points close as the rotor moves into the position shown in Fig. 11 and at a time when projections 64 are separated from projections 21 by a substantial air gap while cores 16 are still substantially covered by projections 19. The closed primary circuit has the effect of resisting flux change in cores 16 while the rotor is moving from the position shown in Fig. 11 to that shown in Fig. 9. Meanwhile, the rotor projections 19 move away from cores 16 and into covering relation with shunt projections 21, preparatory to the spark producing opening of the breaker points above described in connection with Fig. 9.

It will thus be seen that the invention enables the suppression of the spark as the result of magnetic changes effected by the rotor at all but certain selected positions where a spark is desired. Also that the form of invention shown in Fig. 9 is substantially similar so far as the described suppression of spark is concerned, differing only in that the spark is suppressed at two other positions of the rotor and in that better results are obtained due to providing at all times a closed circuit from the magnetic source.

It is not necessarily essential for all purposes that the main and auxiliary breaker point cams be structurally independent as heretofore disclosed and in Fig. 13 both are shown as integral parts of a one piece annular member 70. This member, as shown, is fixed to the rotor by the bolts 71 but, if governor action is desired, it may be had by removing these bolts, the member 70 then being free to turn on the stud 44 as a pivot. It will also be necessary in such case to add a weight and return spring, such as are shown at 45 and 46, respectively, in Fig. 1.

The member 70 has two cam lobes 72 and 73 which may be used interchangeably as the main and auxiliary cams. For clockwise rotation of the rotor, the lobe 72 will act as the main cam and lobe 73 as the auxiliary cam. For anti-clockwise rotation, the same member 70 will serve without change,—the lobe 73 then serving as the main cam and the lobe 72 as the auxiliary cam. If this same member 70 is converted to secure the governor action, the auxiliary cam 73 although integrally united to the main cam 72 will function satisfactorily because it is of short length (as compared to cam 49) and is located substantially diametrically opposite the pivot point 44. Radial movement of cam 72 can then be effected without effecting any substantial degree of radial movement of cam 73.

The invention has utility in a rotary magneto irrespective of whether or not there is a "maverick" spark to be killed. It enables the extra opening and closing of the breaker points for the purpose of allowing flux to build up in the main magnetic circuit (through cores 16) under the best conditions, viz. that of an open circuited primary winding. The flux, thus built up, is held against substantial diminution while the inductor moves into an optimum position for the break of the main magnetic circuit, at which time the breaker points open by the usual means,—cam 42.

The features stressed in the description of the operation of the invention are the essential ones. The invention may be embodied in many forms differing specifically from that herein shown. The use of two banks of magnets, while desirable, is not necessarily essential for all purposes. The same effects, but differing in degree, would also be obtained if one coil unit were omitted from one core 16. Also, these two coils need not necessarily be connected in series as shown. They might even function as independent units. Various other changes may readily be made and the details hereinabove described are not to be considered essential to my invention except insofar as they are included in the appended claims.

What I claim is:

1. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted during each revolution of the rotor to make and subsequently break a magnetic circuit from said source through said pole pieces and rotor, primary and secondary windings associated with said magnetic circuit normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into position relatively to said pole pieces to make said magnetic circuit and for closing them prior to the breaking of said magnetic circuit and again opening said points when the rotor moves into position to break said magnetic circuit and again closing them after said last named break.

2. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted in a plurality of positions during each revolution of the rotor to make and subsequently break a magnetic circuit from said source through said pole pieces and rotor, primary and secondary windings associated with said magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into one but not the other of said positions and for closing them prior to the movement of the rotor out of such position and for again opening the breaker points when the rotor has moved out of such position far enough to cause an effective break in the magnetic circuit and for shortly after closing the breaker points and maintaining them closed while the rotor passes through the other of said positions.

3. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted during each revolution of the rotor to make and subsequently break a main magnetic circuit from said source through said pole pieces and rotor, extensions one from each pole piece extending into the path of said rotor projections for cooperation therewith to make a shunt magnetic circuit from said source shortly before the main magnetic circuit is broken and to subsequently break the shunt circuit, primary and secondary windings included in the main magnetic circuit but lying outside said shunt magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into position relatively to said pole pieces to make said main magnetic circuit and for closing them

prior to the breaking of said main magnetic circuit and prior to the establishment of said shunt circuit and for again opening said points when the rotor moves into position to break said main magnetic circuit and while said shunt circuit is established and again closing them after said last named break.

4. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having projections thereon movable in close proximity to said pole pieces and adapted in at least two positions during each revolution of the rotor to make and subsequently break a main magnetic circuit from said source through said pole pieces and rotor, extensions one from each pole piece extending into the path of said rotor projections for cooperation therewith to make a shunt magnetic circuit from said source shortly before the first named magnetic circuit is broken and to subsequently break the shunt circuit, primary and secondary windings included in the main magnetic circuit but lying outside said shunt magnetic circuit, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the rotor moves into one but not the other of said positions and for closing them prior to the movement of the rotor out of said one of said positions and prior to its movement into position to make said shunt circuit and for again opening the breaker points when the rotor has moved far enough out of said one of said positions to create an effective break in the main magnetic circuit and to make said shunt circuit and for shortly after closing the breaker points and maintaining them closed while the rotor passes into and through the other of said positions.

5. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a magnetic circuit from said source, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into position to make said magnetic circuit and causing them to close prior to the breaking thereof and to again open them when the inductor moves into position to break said magnetic circuit and to again close them after said last named break.

6. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a magnetic circuit from said source at least twice during each revolution of the inductor, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into one but not the other of its positions in which a magnetic circuit is made and causing them to close prior to the breaking of such magnetic circuit and causing them to again open when the inductor moves into position to break such magnetic circuit and causing them to again close and remain closed while the inductor moves into the other positions in which a magnetic circuit is made.

7. In a magneto, a source of magnetic flux, a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a main magnetic circuit from said source, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with said inductor projections to make a shunt magnetic circuit from said source just prior to the breaking of the main circuit, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into position to make the main magnetic circuit and causing them to close prior to the breaking thereof and prior to the making of said shunt magnetic circuit and to again open them when the inductor moves into position to break the main magnetic circuit and after the shunt circuit has been established and to again close them after said last named break.

8. In a magneto, a source of magnetic flux,

a pair of pole pieces connected one to each polar extremity of said source and terminating with substantially opposed polar faces, a rotary inductor mounted between said faces and having substantially diametrically opposed projections to cooperate therewith and make and break a main magnetic circuit from said source at least twice during each revolution of the inductor, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with the projections of the inductor to make a shunt magnetic circuit from said source just prior to the breaking of the main circuit, primary and secondary windings on at least one of said pole pieces, normally-closed but relatively movable breaker points, an electrical circuit including said primary winding and breaker points, said electrical circuit being opened and closed by the opening and closing of the breaker points, and means movable with the inductor for controlling the breaker points and causing them to open as the inductor moves into one but not the other of the positions in which the main magnetic circuit is made and causing them to close prior to the breaking of the main magnetic circuit thus formed and prior to making of the shunt circuit and causing them to again open after the shunt circuit has been made and after the inductor has moved far enough to create an effective break in the first named magnetic circuit and causing them to again close and remain closed while the inductor moves into and through the other positions in which a magnetic circuit is made.

9. A magneto, including a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor cooperating with said pole pieces to make and break a magnetic circuit from said source, primary and secondary windings associated with said circuit, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by said breaker points, means movable with said inductor and movable relatively thereto in response to variations in the speed thereof for opening said breaker points after said magnetic circuit has been broken and for subsequently closing said breaker points, and a second means independent of the first named means and movable with said rotor for opening said breaker points as the inductor approaches the position in which to make said magnetic circuit and for closing them after said magnetic circuit has been made and prior to the breaking thereof.

10. A magneto, including a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor cooperating with said pole pieces in at least two positions during each revolution to make and break a magnetic circuit from said source, primary and secondary windings associated with said circuit, normally-closed but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by said breaker points, means movable with said inductor and movable relatively thereto in response to variations in the speed thereof for opening said breaker points after the inductor moves out of one but not the other of said positions, and a second means independent of the first named means and movable with said inductor for opening said breaker points just prior to the time when the inductor moves into said one of said positions and for closing the breaker points before the inductor moves out of said one of said positions, whereby when the inductor moves into and through the other of said positions the breaker points are maintained closed.

11. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor having substantially diametrically opposed projections, said pole pieces extending into cooperative relation with said inductor and terminating closely adjacent the path of said projections in substantially diametrically opposed relation, said inductor by its rotation making and breaking a main magnetic circuit from said source, primary and secondary windings on at least one of said pole pieces, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperation with said projections to make and break a shunt magnetic circuit from said source in a low reluctance path outside said windings, a normally closed electrical circuit in which said primary winding is included, relatively movable breaker points to control said electrical circuit, and means for operating said breaker points including a governor operated cam movable with the inductor for opening the breaker points after said main circuit has been broken and said shunt circuit made and for shortly after closing said points, and an independent cam movable with the inductor for opening said points when the inductor moves into position to make said main circuit and for closing them before the main circuit is broken and the shunt circuit established.

12. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotary inductor having substantially diametrically opposed projections, said pole pieces extending into cooperative relation with said inductor and terminating closely adjacent the path of said projections in substantially diametrically opposed relation, said inductor by its rotation making and breaking a main magnetic circuit from said source in at least two ranges of travel during each revolution, primary

and secondary windings on at least one of said pole pieces, extensions one from each pole piece terminating with substantially diametrically opposed faces for cooperating with said projections to make and break a shunt magnetic circuit from said source in a low reluctance path outside said windings, a normally closed electrical circuit in which said primary winding is included, relatively movable breaker points to control said electrical circuit, and means for operating said breaker points including a governor operated cam movable with the inductor for opening the breaker points after the inductor moves out of one but not the other of said ranges and causes a break in the magnetic circuit through said windings and for subsequently closing said points and maintaining them closed while the inductor moves through the other of said ranges, and an independent cam movable with the inductor for opening said points while the inductor moves in said one of said ranges and for closing them before the inductor leaves such range to break the main magnetic circuit and before the inductor moves into position to establish said shunt circuit.

13. In a rotary magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, a rotor having a plurality of pairs of projections thereon, each such pair arranged to interconnect said pole pieces during a certain range of travel of the rotor, other projections from said magnetic source cooperating successively with said pairs of rotor projections to make and break a shunt magnetic circuit from said source, said rotor projections being so spaced and located with respect to said pole pieces and second named projections as to provide at all positions a closed magnetic circuit from said source either through said pole pieces or through said shunt path, primary and secondary windings on at least one of said pole pieces, normally-engaged but relatively-movable breaker points, an electrical circuit including said primary winding and breaker points and arranged to be opened and closed by the separation and engagement respectively of said breaker points, and means movable with the rotor for opening the breaker points when the pole pieces are interconnected by one pair of rotor projections and for closing them before said pair of projections move out of such interconnecting relation and for again opening them after the said pair of projections have moved out of such relation and into interconnecting relation with the shunt forming projections and for shortly thereafter closing said breaker points and maintaining them closed while the rotor moves into and through another range of travel in which said pole pieces are interconnected by a pair of rotor projections.

14. In a magneto, a source of magnetic flux, pole pieces connected one to each polar extremity of said source, shunt forming projections connected one to each polar extremity of said source, a rotor having a plurality of pairs of projections to cooperate successively with said pole pieces and shunt forming projections to maintain at all times a closed magnetic circuit from said source either through said pole pieces or through said shunt forming projections, primary and secondary windings on at least one of said pole pieces, a normally closed electrical circuit including said primary winding, and means controlled by movement of the rotor for opening, closing and again opening said electrical circuit while the rotor moves through a selected one of its several ranges in which a magnetic circuit is made and subsequently broken through said pole pieces and for thereafter closing said circuit and holding it closed while the rotor moves through another one of said ranges.

15. In a rotary magneto the combination of means comprising a magnetic source, cooperating pole pieces, an inductor means to cooperate with the pole pieces to establish magnetic circuits from said source through the pole pieces and inductor, the inductor and pole pieces being relatively rotatable so as to make and break successive magnetic circuits during each revolution, an electrical circuit arranged for inductive relation to all the magnetic circuits, a make and break device in said electrical circuit and operable by the rotation of the magneto for the spark producing operation, once in each revolution of said magneto, additional means mounted for operative movement by the rotating part of the magneto to open and close the electrical circuit before the part of the magneto's revolution occurs, when the flux in a particular one of the magnetic circuits is utilized in the aforementioned spark producing operation.

16. In a magneto of the rotary inductor type operable to successively establish maximum and minimum magnetic flux in different magnetic circuits, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable to open and close upon continuous relative rotation of said means and inductor for a single spark producing effect per revolution of said inductor, and additional means positioned so as to open and close said electrical circuit and fully establish said magnetic flux before said first mentioned make and break device opens said electrical circuit.

17. In a magneto of the rotary inductor type, the combination of an inductor, means to successively make and break a plurality of magnetic circuits through the inductor upon each relative and complete rotation of

the inductor and said means, a normally closed electrical circuit in inductive relation to said magnetic circuits, a usual make and break device operable by the magneto's rotation to open and close the electrical circuit once in each revolution after one of said magnetic circuits is broken and before the succeeding magnetic circuit is made, additional means operable by the magneto's rotation to open and close said electrical circuit before the time of said first-named opening to aid the establishment of magnetic flux in preparation for said first-named opening.

18. In a magneto of the rotary inductor type in which a plurality of maximum and minimum flux changes occur on each revolution, only one of which is desired for use in effecting a single spark producing result, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable upon continuous relative rotation of said means and inductor for a spark producing effect once for each revolution of said magneto, a governor on the rotating part of the magneto operable to render said make and break device ineffective upon excessive speed of rotation, and an additional make and break device mounted on the rotating part of the magneto operable in each revolution of the magneto to open and close the electrical circuit, said additional make and break device being operable independently of the governor's action for controlling the electrical circuit to open it at a time in the magneto's rotation when if closed the electrical circuit would choke off a desired establishment of the flux.

19. In a rotary magneto the combination of means comprising a magnetic source, cooperating pole pieces, an inductor means to cooperate with the pole pieces to establish magnetic circuits from said source through the pole pieces and inductor, the inductor and pole pieces being relatively rotatable so as to make and break successive magnetic circuits during each revolution, an electrical circuit arranged for inductive relation to all the magnetic circuits, a make and break device in said electrical circuit and operable by the rotation of the magneto for the spark producing operation, once in each revolution of said magneto, additional means mounted for operative movement by the rotating part of the magneto to open and close the electrical circuit before the part of the magneto's revolution occurs, when the flux in a particular one of the magnetic circuits is utilized in the aforementioned spark producing operation, and a governor device on the rotatable part of the magneto operable on excessive speed of the magneto's rotation to put the first-mentioned make and break device out of operation, said additional means to open and close said electrical circuit being operable at any speed independently of the governor.

20. In a magneto of the rotary inductor type operable to successively establish maximum and minimum magnetic flux in different magnetic circuits, the combination of means for a magnetic field, an inductor, an electrical circuit, a usual make and break device for the latter operable to open and close upon continuous relative rotation of said means and inductor for a single spark producing effect per revolution of said inductor, and additional means positioned so as to open and close said electrical circuit and fully establish said magnetic flux before said first-mentioned make and break device opens said electrical circuit, and a governor rotatable with the magneto to put only the first-mentioned make and break device out of operation on excessive speed of the magneto.

21. In a magneto of the rotary inductor type, the combination of an inductor, means to successively make and break a plurality of magnetic circuits through the inductor upon each relative and complete rotation of the inductor and said means, a normally closed electrical circuit in inductive relation to said magnetic circuits, a usual make and break device operable by the magneto's rotation to open and close the electrical circuit once in each revolution after one of said magnetic circuits is broken and before the succeeding magnetic circuit is made, additional means operable by the magneto's rotation to open and close said electrical circuit before the time of said first-named opening to aid the establishment of magnetic flux in preparation for said first-named opening, and a speed governor operable to put the first-mentioned make and break device out of operation when the magneto speed exceeds a predetermined value, said additional means to open and close said electrical circuit being operable in each revolution of the magneto not only when the first-mentioned make and break device is in operation but also when it is not in operation.

In testimony whereof I have affixed my signature.

KENNETH A. HARMON.

Dec. 4, 1934. C H DAVIS, JR 1,983,072

IGNITION APPARATUS

Filed July 14, 1932 3 Sheets-Sheet 1

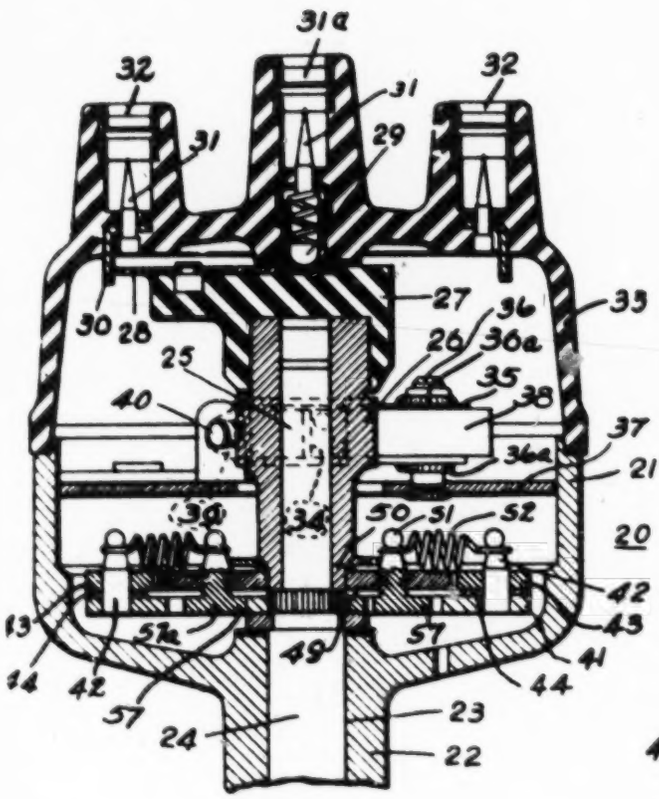

Fig. 1

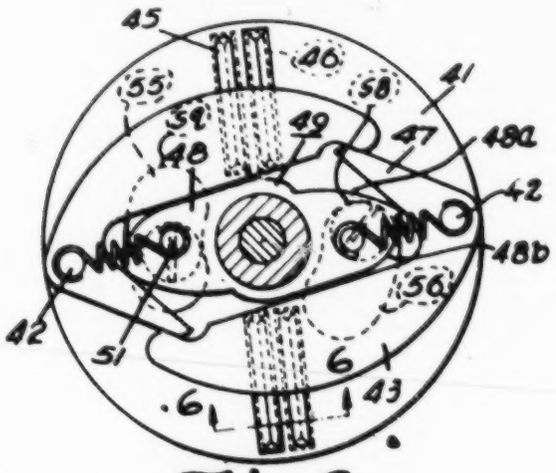

Fig. 2

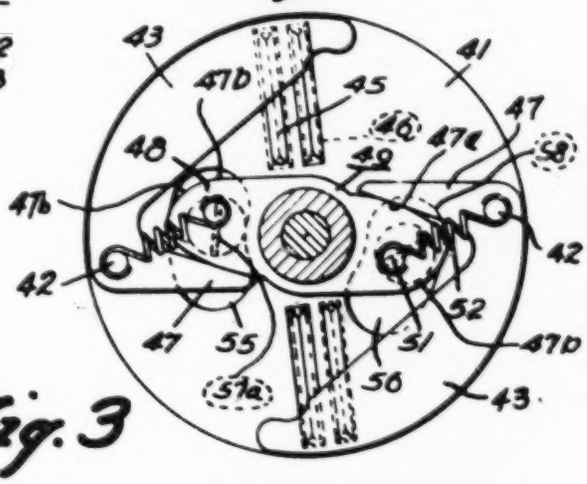

Fig. 3

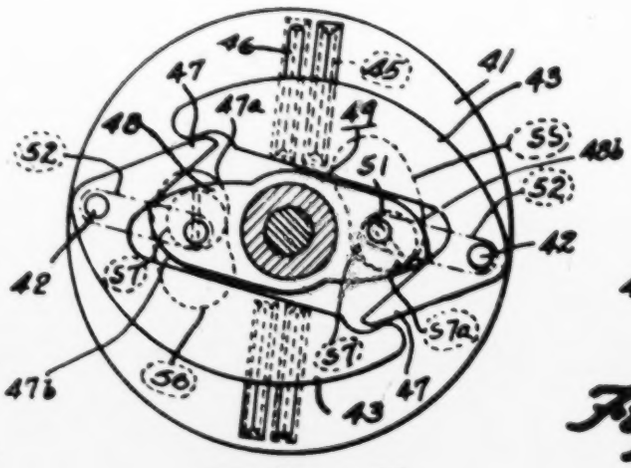

Fig. 5

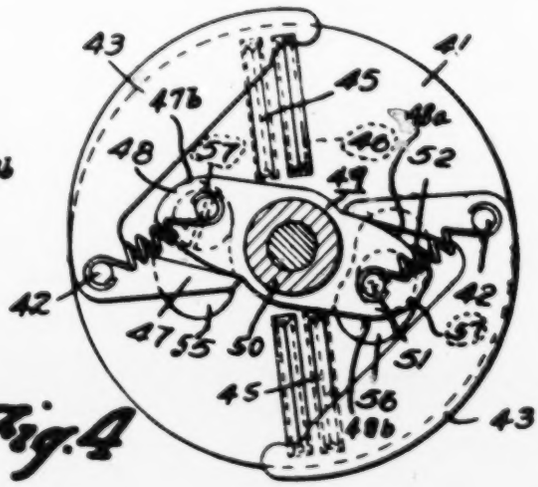

Fig. 4

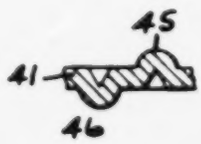

Fig. 6

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By Spencer Hardman & Fehr

Attorneys

P-247

Dec. 4, 1934. C. H. DAVIS, JR 1,983,072

IGNITION APPARATUS

Filed July 14, 1932 3 Sheets-Sheet 2

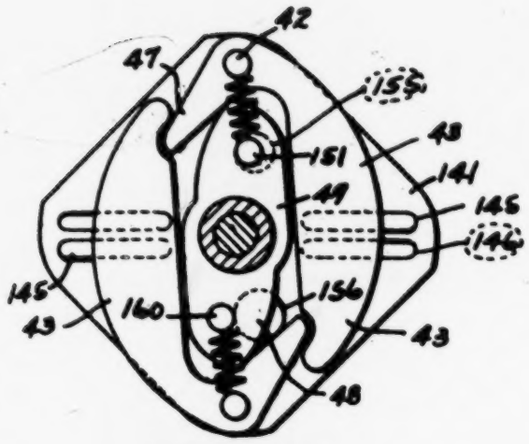

Fig 7

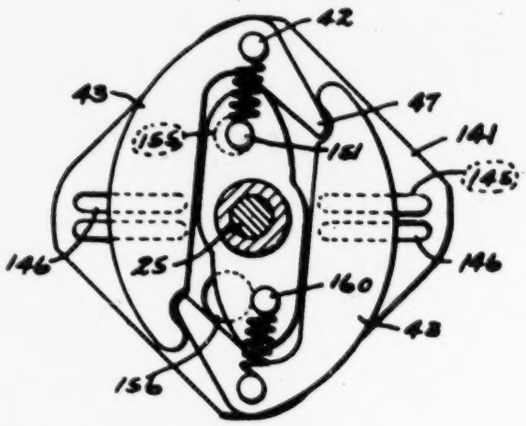

Fig 8

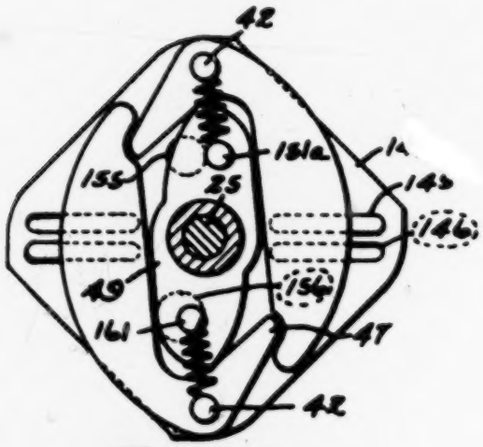

Fig. 9

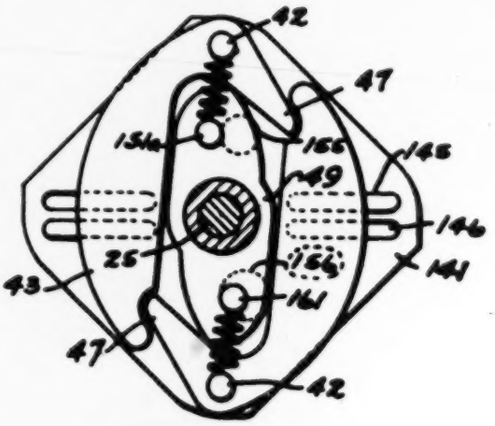

Fig. 10

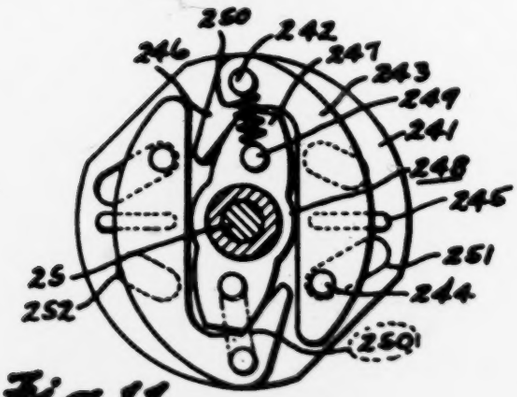

Fig. 11

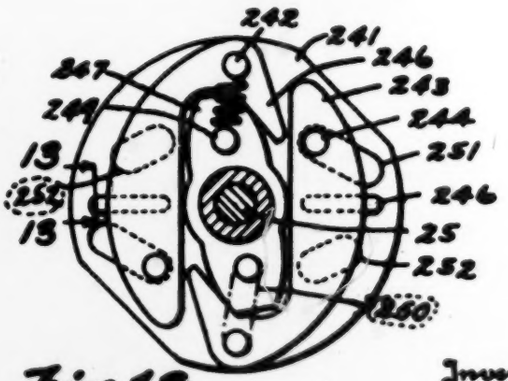

Fig. 12

Fig. 13

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Attorneys

Dec. 4, 1934. C. H. DAVIS, JR. 1,983,072

IGNITION APPARATUS

Filed July 14, 1932 3 Sheets-Sheet 3

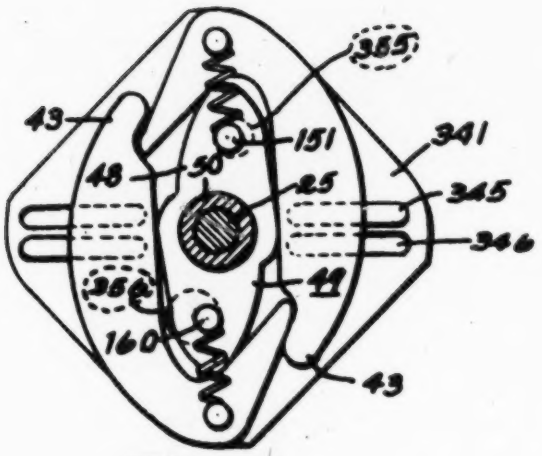

Fig 14

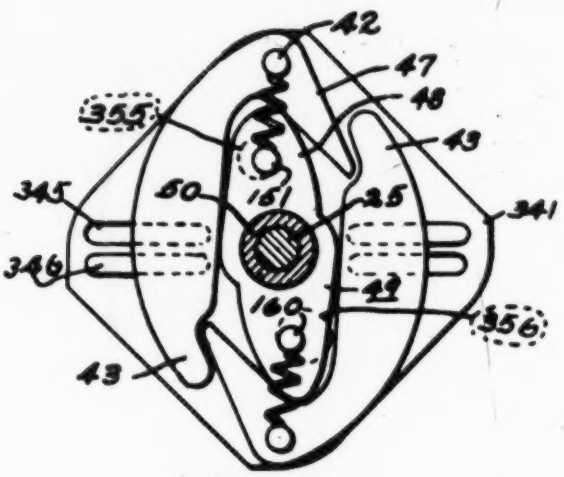

Fig 15

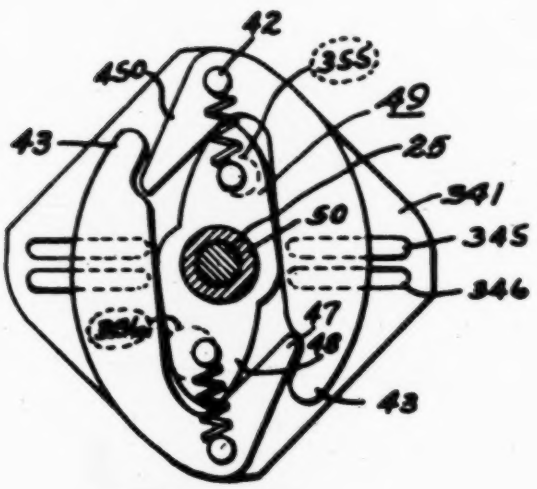

Fig 16

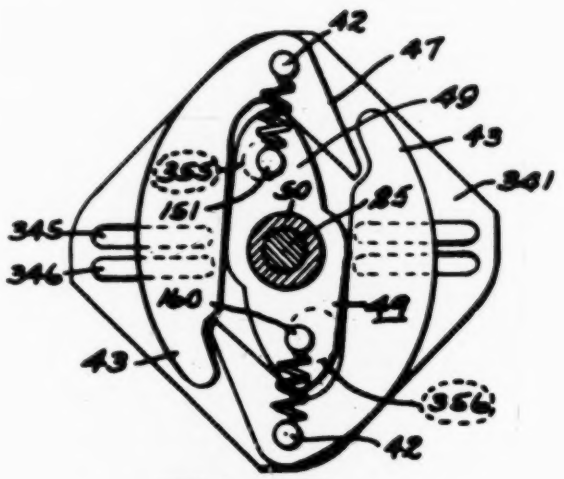

Fig 17

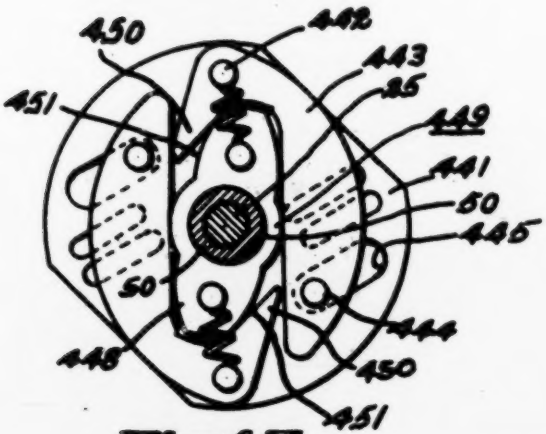

Fig 18

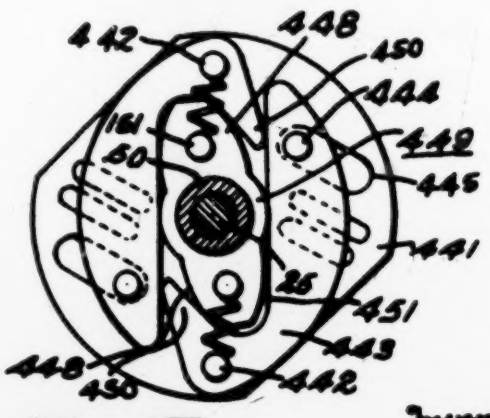

Fig 19

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Attorneys

Patented Dec. 4, 1934 1,983,072

UNITED STATES PATENT OFFICE

1,983,072

IGNITION APPARATUS

Charles H. Davis, Jr., deceased, late of Anderson, Ind., by John T. Fitzsimmons, administrator, Anderson, Ind., assignor, by mesne assignments, to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application July 14, 1932, Serial No. 622,471

16 Claims. (Cl. 64—90.5)

This invention relates to ignition apparatus for internal combustion engines, and more particularly to ignition apparatus having an engine speed responsive device which controls the angular relation between the ignition timer cam and the engine part which drives it, whereby to vary the timing of the ignition impulse relative to the cycle of engine operation.

An object of the present invention is to provide an ignition apparatus with a universal speed responsive device which is efficient and reliable in operation. This is accomplished by providing a speed responsive device with a set of parts, such as weights, lever arms, studs, and supporting plate that are interchangeable and reversible so that by a slight rearrangement it may be made to operate in either direction of rotation of its driving shaft. Furthermore the speed responsive device provides a structure that will produce the proper spark advance for a wide range of engine speed and power conditions. In this manner the number of different parts required for producing a speed responsive device for an entire line of ignition apparatus to suit different engine requirements will be reduced to a minimum.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a cross-sectional view of a distributor embodying the present invention.

Fig. 2 is a plan view showing the speed responsive device for clockwise rotation.

Figs. 3 and 4 are plan views showing the speed responsive device in part and full advance positions, respectively.

Fig. 5 is an assembly of parts adapted for counterclockwise rotation.

Fig. 6 is a sectional view on the line 6—6 of Fig. 2.

Fig. 7 is a plan view of a modified form of a speed responsive device showing an assembly of the rotating parts adapted for clockwise rotation.

Fig. 8 is a plan view of an assembly of the rotating parts for counterclockwise rotation.

Fig. 9 is a plan view similar to Fig. 7 to permit a greater advance of the rotating parts for a clockwise rotation.

Fig. 10 is a plan similar to Fig. 8 to allow a greater advance of the rotating parts for a counterclockwise rotation.

Fig. 11 is a plan view of another modified form of the speed responsive device showing an assembly of the rotating parts adapted for a clockwise rotation.

Fig. 12 is a plan view showing the parts illustrated in Fig. 11 adapted for a counterclockwise rotation.

Fig. 13 is a sectional view taken on line 13—13 of Fig. 12.

Fig. 14 is a plan view of another modified form of a speed responsive device illustrating an assembly of rotating parts adapted for clockwise rotation.

Fig. 15 is a plan view of an assembly of parts used in the assembly shown in Fig. 14 and showing the parts adapted for counterclockwise direction.

Figs. 16 and 17 respectively are plan views similar to Figs. 14 and 15 respectively to permit a greater advance of the rotating part for a clockwise and counterclockwise rotation, respectively.

Fig. 18 is a plan view of another modified form of a speed responsive device showing an assembly of parts adapted to be rotated in a clockwise direction.

Fig. 19 is a plan view showing the parts illustrated in Fig. 18 adapted for a counterclockwise rotation.

Referring to the drawings, 20 designates an ignition distributor comprising a timer cup 21 having a shank 22 to provide a bearing surface 23 for an ignition timer drive shaft 24. The shaft has an extension 25 of smaller diameter providing a journal for a timer cam 26 mounted thereon and free to rotate relative thereto. The cam 26 is drivingly connected with, and supports a rotor 27 carrying a segment 28. One end of the segment 28 cooperates with a central, stationary distributor contact 29, and the other end of the segment cooperates with distributor inserts 30 arranged in a circular row. The contact 29 and inserts 30 are connected electrically with needles 31, the needle 31 engaging the strands of high tension cable leading from any suitable coil provided in the ignition circuit (not shown). This high tension cable is received by a central socket 31a of a distributor head 33. A series of sockets 32 are provided on the distributor head 33 in equally spaced relation and arranged in a circular row about the central socket 31a, these sockets 32 are adapted to receive wires (not shown) that are directed to the spark plugs

of an engine which the distributor 20 is attached.

The cam 26 cooperates with a rubbing block 34 of an insulating material 35 pivoted upon a stud 36 [illegible] by a plate 37 but insulated from the arm 35 by an insulating bushing 36a. The plate is mounted in any suitable manner within the cup 21. A leaf spring 38 electrically connected to the breaker arm 35 urges the rubbing block 34 toward the cam 26. The spring 38 serves to conduct the current to the circuit breaker lever 35 and a movable contact 39 carried thereby. When the cam is out of engagement with the block 34 the contact 39 is urged by the spring 38 into engagement with a stationary timer contact 40.

The shaft 24 carries and drives a weight supporting plate or base 41 to which are attached studs 42, each stud serving as a pivot post for a weight 43. Each weight 43 is spaced from the base 41 by a washer 44 and a rib 45. The plate is also provided with ribs 46. These ribs 45 and 46 are struck up from their respective surfaces of the plate as shown in Fig. 6. The rib 45 tends to reduce friction which would retard the movement of the weights 43 about their pivots 42. Each weight 43 is provided with a finger or tail piece 47 which engages a camming surface of an arm 48 of a lever 49. It will be noted that the arms 48 are provided with two different contours 48a and 48b. These contours are each adapted to engage the fingers 47 of the weights 43 in different combinations. Thus two different types of curves may be had with the same advance cam and either type of curve may be used in either clockwise or counterclockwise rotation depending on the way the different elements comprising the speed responsive device are assembled together to suit the requirements of a particular engine. In either case the lever 49 with the arms 48 must be assembled on the same shaft portion 50 having regard for the direction of rotation of the drive shaft 24. When the lever 49 is suitably attached to a shank portion 50 of the cam 26 the assembly is journalled upon the extension 25. Each of the lever arms 48 carries a post 51 and each post 51 is connected to its adjacent post 42 by a spring 52, said posts 51 are long enough to extend through apertures 55 and 56 provided in the plate 41.

Formed on each extension of the posts 51 is an eccentric portion 57, the post and eccentric are mounted in a predetermined relation upon the lever arms to control the angular movement of the timer cam with respect to the shaft 24. Each eccentric is provided with a slot 57a to facilitate in locating the eccentrics in a correct position upon the lever arms 48 for a predetermined angular movement of the cam 26 relative to the shaft 24. It is to be understood that the studs 51 with the eccentric portion 57 cam be mounted in an infinite number of positions relative to the arm 48 to provide for an infinite number of angular movements of the cam 26 relative to the shaft 24. The holes 55 and 56 are of such size as to receive the eccentrics in all of their possible assembled positions so as to permit a free movement between the plate 41 and the eccentrics to allow the advancing of the cam 26 relative to the timer drive shaft 24. Thus when the device is in operation, centrifugal force acting upon the weights will overcome the resistances of the springs 52 to permit the weights to swing out about their pivots toward the periphery of the plate 41, thereby causing the fingers 47 to rock along the surface 48a of the arms 48 and cause the lever arms to be rotated in a clockwise direction as viewed in Fig. 3, to advance the cam of the ignition timer. The lower end of the studs with the eccentric formed thereon extends into the holes 55 and 56, one of the eccentrics will cooperate with an edge 58 of the apertures 56 in the plate 41 the edge 58 determines the retard position of the cam, while another eccentric will cooperate with an edge 59 of the aperture 55 in the plate that will determine the position of the cam at maximum advance and at the same time limit the outward movement of the weights 43, as shown in Fig. 4. The speed responsive device as viewed in Figs. 2, 3 and 4 is assembled for a timer for which the timer cam shaft is to revolve in a clockwise direction.

If it is desired to adapt the speed responsive mechanism for an installation in which the timer shaft is revolved in a counter-clockwise direction, the plate 41, weights 43, lever 49 and the posts 42 and 51 are reversed as shown in Fig. 5. In other words, the plate 41 and associated parts are assembled in proper relation with respect to each other and are turned bottom upward from the position shown in Fig. 2 to the position shown in Fig. 5. Therefore, in such a construction when the weights swing out the lever 49 will be rotated in a counterclockwise direction relative to the shaft 24 and will advance the cam 26 in a counterclockwise direction. In Fig. 5 the plate has been reversed from that shown in Fig. 2, the weights, 43, pivoted upon the stud will now rest upon the ribs 46, these ribs tend to reduce friction which would retard the movement of the weights about the pivot 42 when the weights fly outward in a clockwise rotation as the cam 26 is rotated in a counterclockwise rotation.

Figs. 7 to 10 inclusive, show a modified form of the present invention for which a supporting plate or base 141 is provided with a plurality of spaced apertures 155 and 156 of different dimensions, each aperture determining the amount of advance of the timer cam for a particular type engine. It will be noted that the spaced apertures in the plate are not diametrically opposite. The plate 141 is provided with ribs 145 and 146 struck up from their respective surfaces. These ribs tend to reduce friction of the weights 43. This construction of the plate 141 performs in a similar manner as that described of the plate 41.

In the device shown in Fig. 7, a post 151 is long enough to extend into the aperture 155 in the plate 141, while another post 160 is free from the plate. This device operates in a similar manner as that shown in Fig. 2, thus centrifugal force will cause the weights 43 to swing out toward the periphery of the plate 141 and will cause the lever 49 to be rotated in a clockwise direction to advance the ignition timer as the speed increases. The lower end of the post 151 extending into the aperture 155 cooperates with plate 141 to provide a stop limiting the movement of the weights 43. When the post 151 is within the aperture 155 shown in Fig. 7, the cam can be advanced substantially 15° in a clockwise rotation. If it is desired to adapt the apparatus for an installation in which the lever 49 is revolved in a counter-clockwise direction to advance the cam 15° in a counter-clockwise direction, the plate 141, the lever 49, and the weights 43 are reverse upon a horisontal line of Fig. 7 and assembled as shown in Fig. 8. In such a construction the weights will swing out in clockwise direction and advance the arms 48 which in turn advance the cam 26 in a counter-clock-

wise direction. It is also necessary to assemble the posts 151 and 160 upon the proper face of the arms 48.

When an engine requires 25° advance of the cam, a post 161 of the speed responsive device is made long enough to extend into the hole 156 in the plate 141 while a post 151a will not extend to the plate 141. As shown in Fig. 9, the device is assembled so that the speed responsive device will be operated in a clockwise direction, that is, as the plate 141 is rotated in a clockwise direction the weights will swing out toward the periphery of the plate 141 in a counter-clockwise direction and advance the cam substantially 25° in a clockwise direction. If it is desired to adapt the apparatus for an installation in which the cam is advanced 25° in a counterclockwise direction the plate 141, lever 49, and the weights 43 are reversed upon a horizontal line of Fig. 9, and assembled as shown in Fig. 10. In such a construction the weights will swing out toward the periphery of the plate 141 in a clockwise direction and advance the cam substantially 25° in a counterclockwise direction. It will be necessary to assemble the studs 161, 151a, and studs 42 upon the proper face of the lever arms 48 and plate 141.

Figs. 11 and 12 illustrate another modified form of a speed responsive device having a supporting plate 241 to which are attached weight studs 242, each serving as a pivot for a weight 243. These weights are provided with pins 244 or lugs extending down from the lower surface of the weight 243. Each weight is spaced from the plate 241 by a spacer about the stud 242, not shown, and rests upon a rib or ridge 245 or 246 struck from the surfaces of the plate by a suitable punch and die device. The ribs formed are illustrated in Fig. 13. These ribs tend to reduce friction which would retard the movement of the weight levers 243 about their pivot posts 242. Each weight is provided with a finger 246 which engages an arm 247 of a lever arm 248. The arm is attached to the lower end of a cam shaft which may be journalled upon the reduced upper end 25 of the driving shaft 24 illustrated in Fig. 1. Each arm 247 carries a spring post 249; each post 249 is connected by a spring 250 with an adjacent post 242. The pins or lugs 244 extend into apertures 251 in the plate 241. Obviously, centrifugal force will cause the weights 243 and pins 244 to swing toward the periphery of the plate 241 and will cause the lever arms 247 to be rotated in a clockwise direction, as shown in Fig. 11, to advance the ignition timer cam as the speed increases; the pins extending into the apertures 251 cooperate with plate 241 to provide a stop limiting the outward movement of the weights 243.

If it is desired to adapt the apparatus for an installation in which the timer shaft is revolved in a counterclockwise direction, the plate 241 is reversed and the weights are reversed upon the posts 242 upon a horizontal line of Fig. 11 and assembled as shown in Fig. 12. It is to be understood that the posts 242 are assembled upon the proper face of the plate 241. Thus, the weights are arranged for clockwise rotation outwardly upon their pivot post 242. When the speed responsive device is at rest, the pins 244 will practically touch the inner edge of the apertures 251. When the pins 244 are within the apertures shown in Figs. 11 and 12 respectively, the cam is advanced substantially 28° in clockwise and counterclockwise directions respectively.

When an engine requires substantially 12° advance of the cam for either clockwise or counterclockwise direction of rotation the pins 244 upon the weights are placed within the apertures 252 in the plate 241. Therefore, the aperture 252 serves the same purpose as the apertures 251 when the speed responsive devices are assembled for engines requiring a smaller advance movement of the cam.

Figs. 14 and 15 inclusive show another modified form of the present invention having a supporting plate 341. The plate is provided with a pair of spaced apertures 355 and 356 of different dimensions, the apertures being substantially diametrically opposite each other, each aperture determining the amount of advance of the timer cam. The plate is provided with ribs 345 and 346 struck up from their respective surfaces and serves the same purpose as the ribs 45 and 46 do when the apparatus is in operation.

In the construction shown in Figs. 14 and 16 the assembly comprising the shaft 25 and the plate 341 and the assembly comprising the lever 49 and the cam 26 can be used for both a 15° and 25° advance of the ignition timer in a clockwise rotation. For a 15° advance, (see Fig. 14) the pin 151 extends into the hole 355 in the plate 341, while the other post 160 does not extend to the plate. Obviously centrifugal force will cause weights 43 to swing out toward the periphery of the plate 341 and will cause the lever 49 to be rotated in clockwise rotation to advance the ignition timer. The lower end of the pin 151 extending into the hole 355 cooperates with the plate 341 to provide a stop limiting the movement of the weights 43.

Should a 25° advance of the ignition timer be desired, the lever 49 and cam 26 assembly is rotated 180° on the shaft 25 so that the pin 151 will extend into the aperture 356 (see Fig. 16) or the pin 160 may have an extension extending into the aperture 356 and the pin 151 will not extend to the plate 341.

If it is desired to adapt the apparatus for an installation in which the timer shaft is revolved in a counterclockwise direction the assembly of the plate 341 is turned upside down and assembled to the shaft 25 and the lever 49 is turned upside down and assembled to the cam shank portion 50 and assembled as shown in Figs. 15 and 17. It is to be understood that the posts 42 and the pins 151, 160 are assembled upon the proper surfaces of the plate 341 and the lever arms 48 respectively. It will be noted that the weights 43 are reversed upon the posts 42 as shown in Figs. 15 and 17, whereby these weights are arranged for clockwise rotation outwardly upon their weight post 42. Therefore, in such a construction when the weights 43 swing out the lever 49 will be rotated in a counterclockwise rotation relative to the shaft 25, and will advance the timer cam 26 in a counterclockwise direction as viewed in Figs. 15 and 17.

Should the apparatus be assembled for a 15° advance of the ignition timer for a counterclockwise rotation of the timer shaft 25 the pin 151 will extend into the aperture 355 as shown in Fig. 15.

If it is desired to have the apparatus assembled so that a 25° advance of the ignition timer is provided for a counterclockwise rotation of the timer, the assembly comprising, the lever 49 and the cam 26 should be moved 180° so that the pin 151 will extend into the aperture 356, or the pin 160 may have a projection extending into the aperture 356 and the pin 151 will not extend into the

aperture 355. In this case the lever and cam assembly need not be rotated 180°.

Figs. 18 and 19 illustrate another modified form of a speed responsive device for which the different parts or elements comprising the speed responsive device may be reversible and interchangeable so that by a slight rearrangement it may be made to operate in either a clockwise or counterclockwise direction of rotation. Thus, the form illustrated in Figs. 18 and 19 comprises a weight plate 441 adapted to be mounted with either face up upon the shaft 25. Studs 442 are provided and adapted to be mounted on either face of the plate 441, each serving as a pivot for a weight 443. The weights are provided with projections or pins 444 adapted to extend into apertures 455 provided in the plate 441. The shaft 25 forms a bearing or journal for the sleeve 50 to which is attached a lever 449 having two arms 448. Each weight 443 has a tail piece 450 which cooperates with a cam edge 451 of the arms 448. Each arm has two symmetrical cam edges and these edges permit the weights to be turned over so that the tail pieces will cooperate with the opposite sides of the arms 448. This permits the same parts to be used with either a clockwise or counterclockwise rotation.

The weights each carry a projection 444 that projects into the slots or apertures 445 and in the plate 441, the projections cooperating with the ends of the slots limit the extreme inward and outward movement of the weights. From an inspection of Fig. 18 it is obvious that as the weights move outwardly, the tail pieces cam against the cam edges of the arms 448 of the lever 449 and advance the lever and timer cam angularly in a clockwise direction of rotation with respect to the shaft 25.

If it is desired to have the apparatus for an installation in which the timer shaft is revolved in a counterclockwise direction, the plate is reversed and assembled upon the shaft 25 as shown in Fig. 19. The weights 443 are also reversed upon their posts, whereby these weights are arranged for clockwise rotation outwardly upon their posts. Therefore in such a construction when the weights swing out, the arms 448 will be rotated in a counterclockwise rotation relative to the shaft 25, and will advance the timer cam in a counterclockwise rotation.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. A speed responsive device comprising in combination; a drive shaft; a driven shaft; a plate having spaced apertures of different dimensions arranged in a non-diametrical relation with respect to each other, said plate adapted to be attached to said drive shaft with either face up dependent on the direction of rotation of said drive shaft; a lever arm adapted to be mounted with either face upon said driven shaft; a pivot post adapted to be carried on either face of said plate; a weight member having a finger, said weight adapted to be rotatably supported on said post with either face adjacent said plate whereby said finger may engage an edge of said arm to angularly adjust said driven shaft from a normal position; and means extending into either of said apertures in said plate and cooperating with said plate to limit the angular movement of said driven shaft in either direction from normal position with respect to said drive shaft.

2. A speed responsive device comprising in combination; a drive shaft; a driven shaft; a plate member carried by said drive shaft and having non-diametrical spaced apertures; a weight member pivotally carried by said plate, an arm member carried by said driven shaft; a stop member carried by said arm member and extending into and cooperating with one of said apertures of said plate to determine the limit of angular movement of said driven shaft with respect to said drive shaft in one direction from normal position; and each of said members capable of being reversed upon their respective carrying means to determine the limit of angular movement of said driven shaft with respect to said drive shaft in the opposite direction from normal position.

3. A speed responsive device, comprising in combination; a drive member; a driven member; and adjustable eccentric means carried by and positioned in predetermined association with said driven member, said eccentric means cooperating with means on said drive member to determine an angular relation of said driven member relative to said drive member.

4. A speed responsive device, comprising in combination, a drive member, a driven member, and a plurality of adjustable eccentric means carried by said driven member cooperating with said drive member controlling the movement of advance of said driven member relative to said drive member, one of said means determining the initial advance movement and another of said means determining the limit of advance movement between said members.

5. A speed responsive device comprising in combination a drive shaft; a driven shaft; a plate member having apertures attached to said drive shaft; weight members pivoted on said plate; a lever member carrying adjustable eccentric members, said eccentric members extending into said apertures of said plate and each of said eccentric members is constructed so that each member can be positioned with respect to each other to provide for a different operable condition for purposes set forth.

6. In a device of the character described, the combination comprising, a drive shaft; a driven member rotatably supported upon said drive shaft; a supporting plate having spaced apertures of different dimensions mounted upon said shaft; a lever arm secured to said driven member; a stud member carried by said lever arm and extending into one of said apertures, said stud cooperating with the said aperture to provide for an angular movement of said driven member relative to said drive shaft for one direction of rotation of the drive shaft; means for actuating said lever arm to provide said angular movement; and said supporting plate, lever arm including said stud member, and actuating means thereof are reversible, whereby the same set of parts function for another direction of rotation of said drive shaft.

7. In a device of the character described, the combination comprising; a drive shaft; a driven member; a supporting plate secured to said drive shaft, said plate having a plurality of non-diametrically spaced apertures of different dimensions; a lever arm connected to said driven member; a stud carried by said lever arm, said stud extending into one of said apertures to control a predetermined angular relation of said driven member relative to said drive shaft in one direction of

rotation; and said parts of said speed responsive device adapted to be reversed upon their respective parts to control a predetermined angular relation of said driven member relative to said drive shaft in another direction of rotation.

8. In a device of the character described, the combination comprising; a drive shaft; a driven shaft; speed responsive means for angularly adjusting the relation of said shafts, said means comprising a weight support having spaced apertures of different dimensions, each aperture providing for different angular relation between the shafts; a pivot post carried by said support; a weight member pivotally mounted on said post; a lever arm secured to said driven shaft and cooperating with said weight members; a stud secured to said arm and extending into one of said apertures to regulate an angular movement of said driven shaft relative to said drive shaft; said speed responsive means having parts so constructed that the same parts may be reversed to provide speed responsive means that will operate for either direction of rotation of said drive shaft.

9. A speed control means comprising, reversible members which include, in combination; a drive plate having a plurality of circumferentially spaced perforations therethrough; weight members pivoted upon said plate; a driven member; a lever connected to said driven member and having arms cooperating with said weight members; and adjustable means carried by one of said arms and projecting into one of said perforations to determine the limit of movement of said lever member relative to said drive plate.

10. A speed responsive mechanism comprising in combination, a drive plate having a plurality of circumferentially spaced perforations of different dimensions therethrough; weight members pivotally mounted upon said plate; a lever having arms cooperating with said weights to advance said lever; and adjustable eccentric means associated with said lever extending within one of said perforations to vary the angular relation of said lever relative to said drive plate.

11. A speed responsive mechanism comprising in combination; a drive plate having a plurality of circumferentially spaced perforations therethrough; weight members pivotally mounted upon said plate; a lever having arms, said arms cooperating with said weights to advance said lever member; and adjustable eccentric means associated with said arms on said lever cooperating with said perforations to form limits for each extreme movement of relative angular shift of the lever with respect to said drive plate.

12. A speed responsive mechanism comprising in combination; a driven shaft; a drive shaft, said shaft rotatably supporting said driven shaft; a weight plate attached to said drive shaft, said plate having spaced apertures therein; fly weights having fingers pivotally supported on said plate; a lever having arms supported by said driven shaft, said arms having edges adjacent said fingers, said fingers operable on said edges to angularly adjust said driven shaft with respect to said drive shaft from a normal position; and eccentric means secured to said arms, provisions for attaching said eccentric means to said arms into infinite positions relative to said arms, said eccentric means extending into and cooperating with said apertures to control the limit of angular relation of said shafts, and said parts of said speed responsive means being constructed so that said parts may be reversible and interchangeable to function for either direction of rotation of said drive shaft.

13. In a speed responsive device, the combination comprising a drive shaft; a driven shaft; eccentric means; provision for attaching said eccentrics to the driven member into infinite positions relative to the driven member; means for connecting the drive member with the driven member for angularly adjusting the driven member from a normal position with respect to the drive member in response to increase in speed; springs for returning said driven member to normal position; and a member connected to the drive shaft and provided with spaced apertures each for receiving one of said eccentric means in one of its positions of attachment to said driven shaft, said apertures being larger than said eccentrics and so arranged that when one of said eccentrics is in one of its positions of attachment to the driven member and extends into one of said apertures, said eccentric cooperates with the apertured member to provide a stop limiting the movement of the driven member in one direction from normal; and when another eccentric is in another position of attachment to said driven shaft and extends into another aperture, said eccentric cooperates with the aperture to provide a stop limiting the movement of said driven member in another direction from normal with respect to said drive shaft.

14. A speed responsive device comprising in combination, a drive shaft; a weight support member carried by said shaft, said member having a plurality of circumferentially spaced perforations of different dimensions therethrough, and said member adapted to be attached in various relations to said drive shaft with either face up dependent on the direction of rotation of said drive shaft; a plurality of centrifugal weights having camming portions and adapted to be mounted with either side up upon studs carried by said member; a driven shaft; a spider having camming arms adapted to be mounted with either side up upon said driven shaft, said driven shaft mounted on said drive shaft for angular displacement relatively thereto, said arms of said spider and camming portions of said weights being arranged so that the weights will move outwardly from said spider; coil springs connecting said arms with said studs to exert a restraining force upon the advancing movement of the advancing spider; and adjustable means carried by said spider extending into one of said perforations of said support to determine the limit of angular movement of said driven shaft with respect to said drive shaft.

15. In a device of the character described, the combination comprising; a drive shaft; a driven shaft journaled upon the drive shaft; a plate member having spaced apertures of different dimensions; an arm member carried by said driven shaft; a stud member supported by said arm member and adapted to extend into one of the apertures of the plate member to determine an angular movement of the driven shaft with respect to the drive shaft from normal position, and said stud member adapted to extend into another aperture of the plate member to determine another angular movement of the driven shaft with respect to the drive shaft from normal position and each of said members capable of being reversed upon their respective carrying means to regulate the angular movements of said shafts with respect to each other in an opposite direction from normal positions.

16. A speed responsive device comprising in combination; a driving member and a driven member arranged to rotate together but relatively movable; weight members pivotally supported on the driving member; a camming connection interposed between the weight members and the driven member for causing relative movement of the driving and driven members when the weights move outwardly; means associated with said driven member having provision for attaching same into infinite positions relative to said driven member and said means cooperating with said drive member controlling the limit of angular relation of said members; and spring means arranged to resist movement of the weight members.

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Sept. 3, 1935. E. P. LITTLEFIELD 2,013,541

INTERNAL COMBUSTION ENGINE

Filed July 5, 1934

Fig. 1.

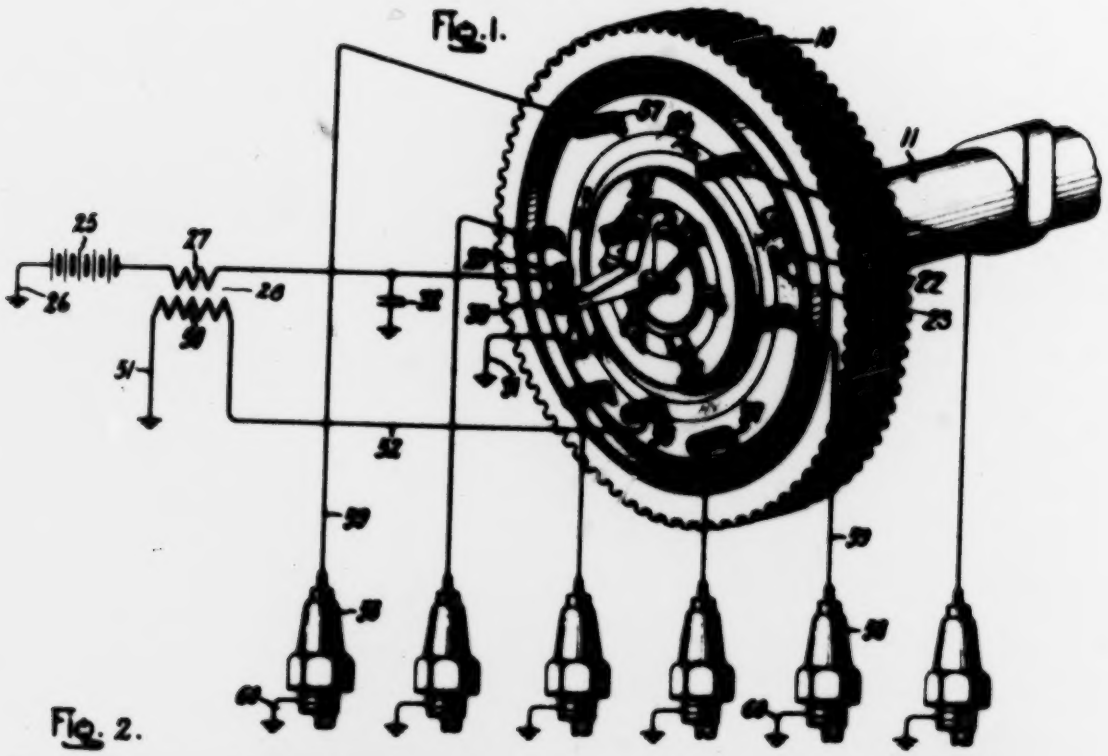


Fig. 2.

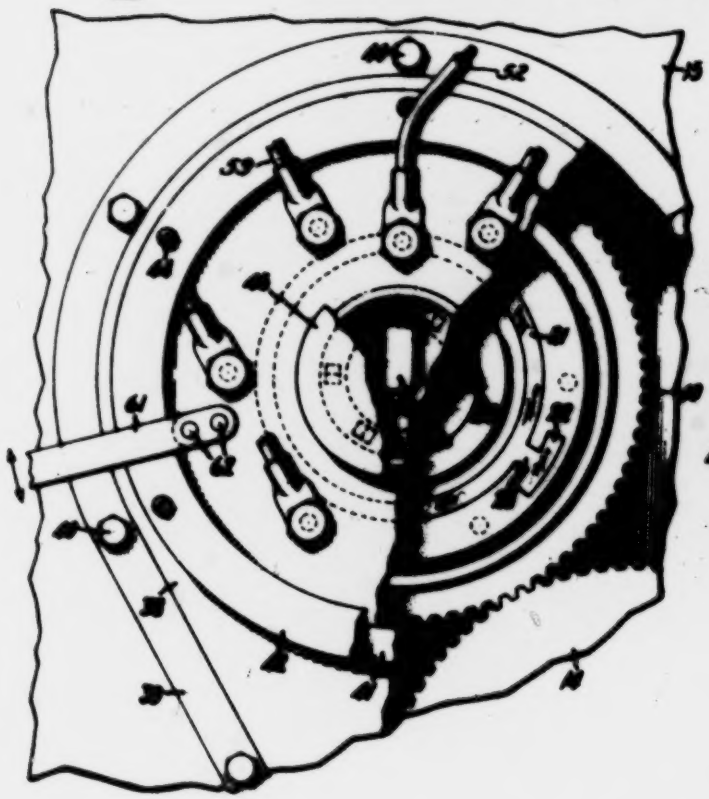
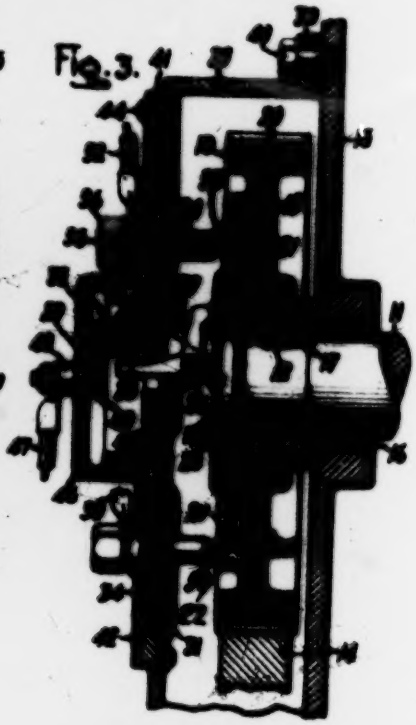


Fig. 3.



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UNITED STATES PATENT OFFICE

2,013,541

INTERNAL COMBUSTION ENGINE

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Application July 5, 1934, Serial No. 733,736

8 Claims. (Cl. 123—146.5)

The present invention relates to internal combustion engines comprising a plurality of cylinders, a crank shaft connected to the pistons in the cylinders and a cam shaft driven from the crank shaft for operating various valves connected to the cylinders. More specifically, the invention relates to the above type of internal combustion engines which includes a timing gear on the cam shaft and an ignition system operated in response to movement of the cam shaft for effecting a succession of timed ignitions in the cylinders.

The object of my invention is to provide an improved construction and arrangement of a timing gear and an ignition system in the type of engines mentioned above which is reliable in operation and can be manufactured at comparatively low cost. This is accomplished in accordance with my invention by uniting the timing gear and certain elements of the ignition system into a single unit, more specifically by the provision of a timing gear made at least partly of insulating material and using the insulated portion of the timing gear as a support for certain elements of the ignition distributing system.

For a better understanding of what I believe to be novel and my invention, attention is directed to the following description and the claims appended thereto in connection with the accompanying drawing.

In the drawing, Fig. 1 represents a perspective view, partly diagrammatic, of a part of an internal combustion engine embodying my invention; Fig. 2 is a front view; and Fig. 3 is a sectional view of Fig. 2.

The arrangement comprises a timing gear 10 secured to an overhung end portion of a cam shaft 11 by means of a key 12 and a screw 13. The timing gear 10 is driven in well known manner from the crank shaft by any suitable means, in the present instance by means including a drive gear 14, meshing with the timing gear 10. The cam shaft 11 projects through an opening in a casing wall 15 of the engine and is supported on said wall through the intermediary of a bearing bushing 16.

The timing gear 10, according to my invention, comprises a steel hub 17 which is molded into a body made of insulating material such as a material including a phenolic condensation product or an artificial resin. The insulating body comprises a web 18 and an outer rim 19 with teeth 20. As stated above, the timing gear is united with and forms an element of an ignition distributing system. This ignition distributing system in the present instance comprises a metal or electric contact ring 21 integrally united with a radially spaced short segment 22 by a bridge 23. The ring 21 with the segment 22 and the bridge 23 is supported on, more specifically, and molded into, the front face of the web 18. The front face of the hub 17 is machined to form a plurality of projections or cam members 24. In the present instance I have indicated six projections which are uniformly angularly spaced, and concentrically arranged with both the cam shaft and the metal ring 21. The metal ring 21, the segment 22 and the aforementioned cam members or projections 24 form parts of the ignition distributing system. The latter has a primary circuit and a secondary circuit. The primary circuit, as diagrammatically indicated in Fig. 1, includes a source of electric energy, such as a battery 25, which on one side is grounded by a wire 26 and on the other side is connected to one end of a primary coil 27 of an ignition transformer 28. The other end of the coil 27 is connected to a circuit interrupting contact or breaker point 29 cooperating with a breaker point 30, which latter is grounded by a wire 31. A grounded capacitor 32 is connected to a point intermediate the primary coil 27 and the breaker point 29. The breaker point 29 is secured to a projection 33 of a plate 34 made of insulating material similar to the material of the body of the timing gear. The insulating plate 34 is disposed in front of the gear face. The breaker point 30 is secured to or forms a part of an arm 35 which is suitably supported on a fulcrum 36 held on the plate 34. Another portion of the arm 35 is disposed adjacent the face of the hub 17 and is biased toward said face by a spring 37. In the position indicated, the breaker points or circuit interrupting or making and breaking contacts 29 and 30 engage each other, permitting a flow of current from the battery 25 through the primary coil 27, through the breaker points and the ground. During rotation of the shaft 11 the arm 35 is successively engaged by the projections 24, causing the arm to swing automatically back and forth to effect opening and closing of the primary circuit.

As stated before, both breaker points are mounted on the plate 34 made of electric insulating or nonconducting material. This plate 34 forms a part of a cover enclosing the timing gear. The other part of the cover is formed by a member or side wall 38 which has a flanged portion 39 secured to the engine casing wall 15 by screws 40, and another recessed portion 41 to which the plate 34 is fastened by means including a ring 42 and a plurality of screws 44. The breaker points 29 and 30 are disposed in front of the plate 34 and enclosed by a cap 45 screwed onto an annular threaded projection 46 of the plate 34. The electrical connection between the primary coil 27 and the breaker point 29, as shown in Fig. 3, is accomplished by means including a wire 47 connected to a screw 48, which latter contacts a lug 49 having a portion secured to the breaker point 29.

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The secondary circuit of the ignition distributing system comprises a secondary coil 60 of the ignition transformer 28 which has one end connected to ground by a wire 61 and another end electrically connected to the aforementioned metal ring 21 by means including a wire 62 and a brush 63. The brush 63, as shown in Fig. 3, is disposed in a bore of a plug 64 and biased towards the metal ring 21 by a spring 65. The spring is compressed by a nut 66 which is screwed onto an outer portion of the plug and also serves to fasten the end of the wire 62 to the plug. The secondary circuit also includes the aforementioned segment 22 electrically connected with the ring 21 by the bridge 23 and six brushes 67 supported on the plate 34 and bearing against an annular portion of the web 18, which annular portion includes the segment 22. Thus, during rotation of the web the segment 22 engages successively the different uniformly, angularly spaced brushes 67. The segment 22 and the ring 21 form a part of the secondary circuit interrupting means Each of the six brushes 67 is connected to a spark plug 68 by a wire 69. One electrode of each spark plug is grounded, as indicated at 68. When the segment 22 contacts one of the brushes 67, the secondary circuit is closed and current flows from one end of the coil 60 through the brush 63, the ring 21, the bridge 23, the segment 22, one of the brushes 67, the corresponding wire 69 and the corresponding spark plug 68 through the ground to the other end of the secondary coil 60.

The plate 34 has a sliding fit in the recessed portion 41 of the member 38. Adjustment of the ignition by advancing and retarding of the spark may be accomplished by rotating the plate 34. To this end a spark-retarding and advancing lever 61 (Fig. 2) is secured to the plate 34 by means of pins 62. The lever 61 may be moved by hand or by well known automatic means, not shown, to change the relative position between the secondary brushes 67 and the segment 22 which latter being fixed to the timing gear has a definite relation to the position of the cylinder pistons, not shown.

Timing of the engine is effected in the usual manner by changing the relative position between the cam shaft and the crank shaft, for example, in the present instance, by demounting the gear 14 to effect disengagement between this gear and the timing gear and thereafter slightly turning the crank shaft, and again mounting the gear 14 to mesh with the timing gear 16.

Having described the method of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In an internal combustion engine, the commination of a cam shaft, a timing gear with a web being secured to the shaft, and an ignition distributing system including means secured to the web of the timing gear.

2. In an internal combustion engine, the combination of a cam shaft, a timing gear secured to the shaft, the timing gear having a web made of insulating material, and a hub having a face with a plurality of angularly spaced projections, and an ignition distributing system comprising a primary circuit with breaker points and a fulcrumed arm supporting one of the breaker points and being actuated by said projections.

3. In an internal combustion engine, the combination of a cam shaft, a timing gear secured to the shaft, the timing gear having a web made of insulating material, and an ignition system comprising a secondary circuit including a metal ring and a segment concentrically spaced from the ring and electrically connected therewith, the segment and the ring being supported on said web

4. In an internal combustion engine, the combination of a casing, a cam shaft supported on and projecting through the casing, a timing gear secured to an overhung portion of the shaft, means enclosing the gear comprising a member fastened to the casing and a plate made of insulating material and disposed in front of the gear, and an ignition distributing system comprising a primary electric circuit including breaker points, one point being fastened to the plate, an arm fulcrumed on the plate and supporting the other point and means on the timing gear for actuating the arm to effect opening and closing of the points during operation.

5. In an internal combustion engine, the combination of a casing, a cam shaft having an overhung portion projecting through the casing, a timing gear having a metal hub secured to the overhung shaft portion and a web made of a material including an artificial resin and united with the hub, means enclosing the gear including a plate disposed in front of the gear and made of a material including an artificial resin, and an ignition distributing system including a ring with a radially spaced segment molded into the web, a brush supported on the plate and engaging the ring and a plurality of brushes held on the plate and engaging an annular portion of the web including said segment whereby rotation of the gear causes in succession electric connections between the first named brush and the other brushes.

6. In an internal combustion engine, a casing, a cam shaft supported on the casing and having a portion projecting out of the casing, a timing gear fastened to said shaft portion and comprising a web made of a material including an artificial resin and a hub with a plurality of angularly spaced projections, an adjustable plate in front of the gear face secured to the casing and made of a material including an artificial resin, and an ignition distributing system comprising a primary and a secondary circuit, the primary circuit including breaker points supported on the plate and means including said hub projections for opening and closing the breaker points, the secondary circuit including brushes held on said plate and means secured to the web for effecting a succession of connections between one of the brushes and the other brushes.

7. In an internal combustion engine, the combination of a cam shaft, a timing gear having a web made of insulating material and a hub secured to the shaft, and an ignition distributing system comprising a primary and a secondary circuit, the secondary circuit including circuit interrupting means mounted on said web.

8. An article of manufacture comprising a gear having a hub with a plurality of angularly, uniformly spaced projections on its face and a web made of a material including an artificial resin, and an electric contact ring concentrically arranged with the projections and secured to the face of the web.

EDWARD P. LITTLEFIELD.

Nov. 2, 1937. E. V. HENNECKE ET AL 2,097,662

UNIVERSAL MOUNTING FOR WINDSHIELD WIPER MOTORS

Original Filed Aug. 23, 1933 3 Sheets-Sheet 1

Fig. 1.

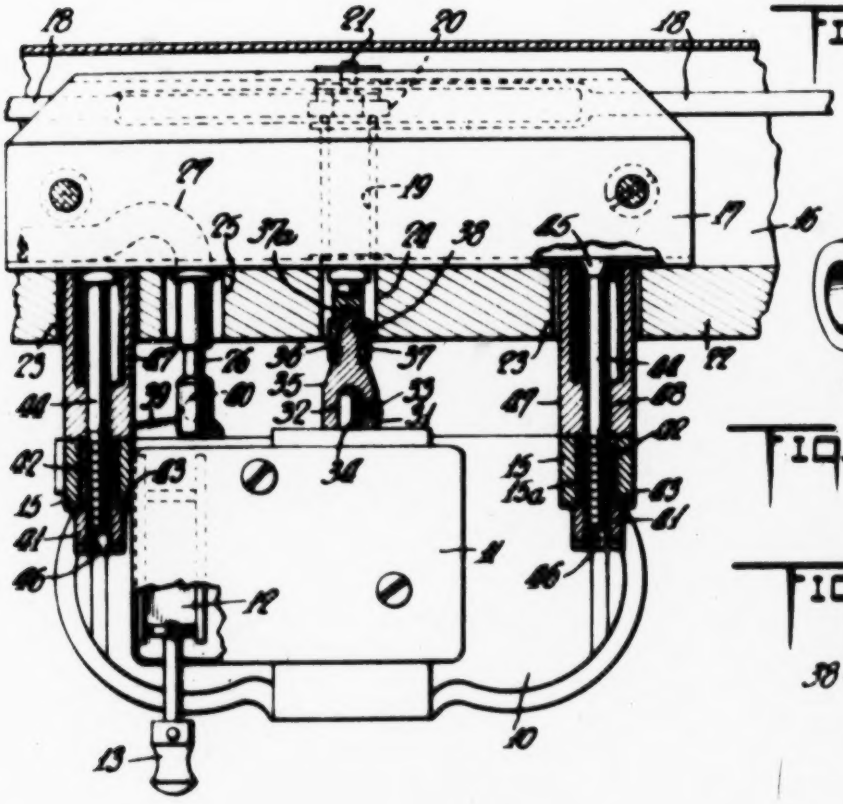


Fig. 2.

Fig. 3.

Fig. 4.

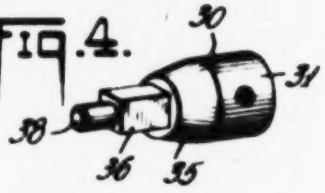


Fig. 5.

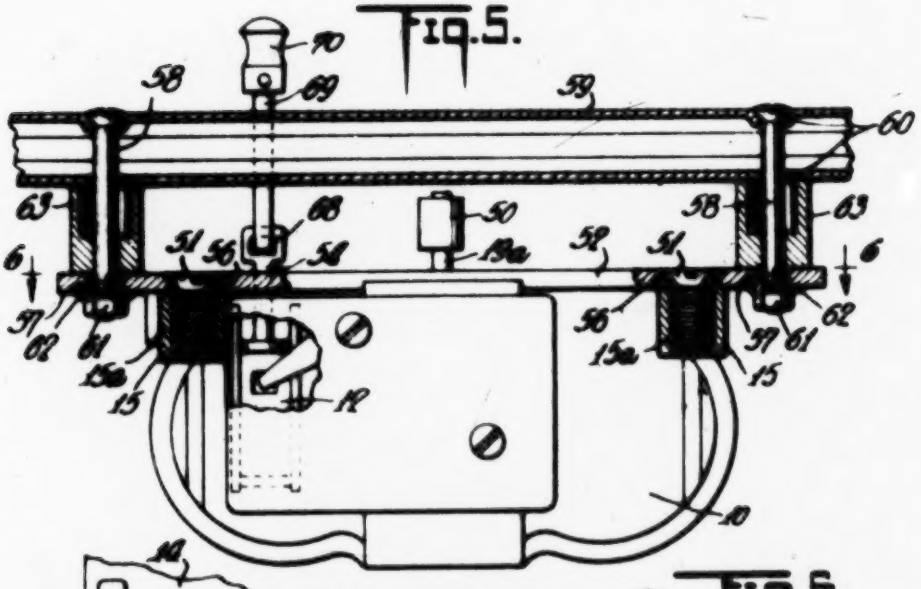
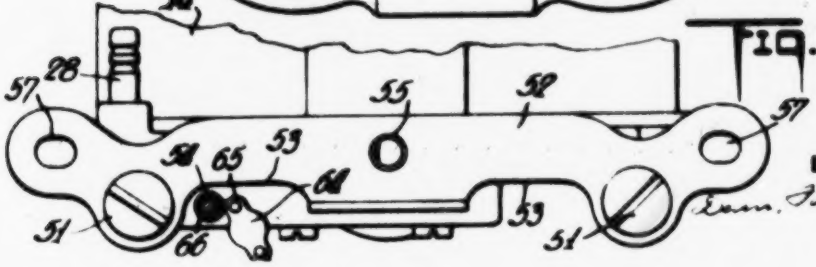


Fig. 6.



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UNIVERSAL MOUNTING FOR WINDSHIELD WIPER MOTORS

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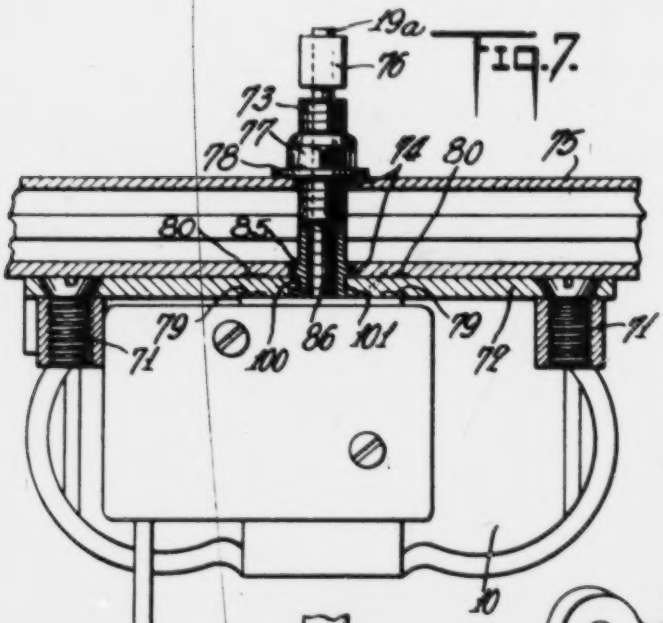

Fig. 7.

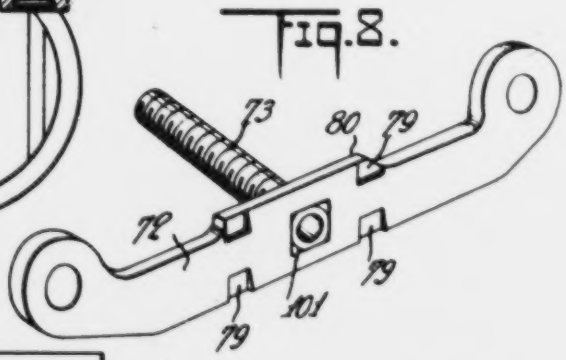

Fig. 8.

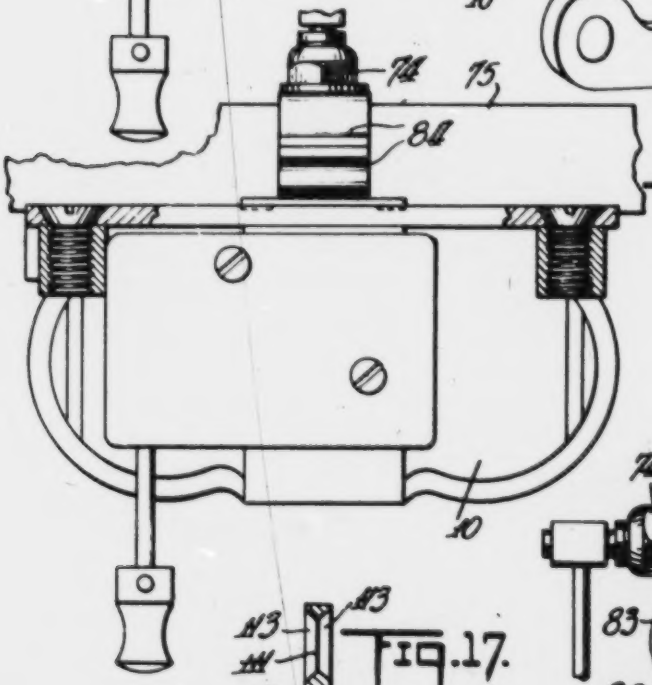

Fig. 9.

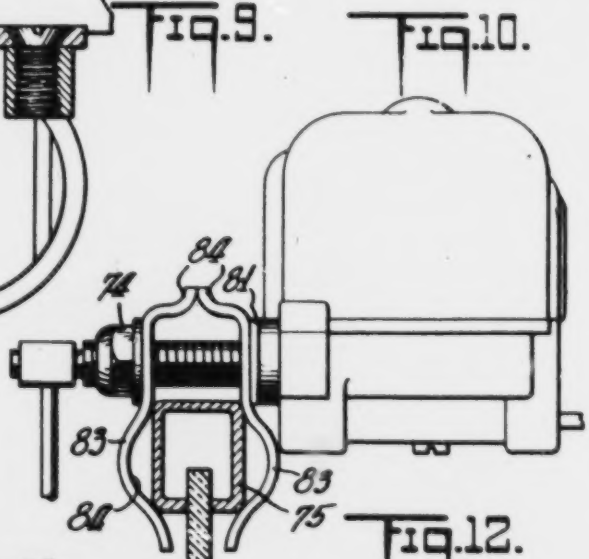

Fig. 10.

Fig. 17.

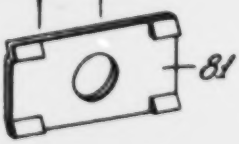

Fig. 12.

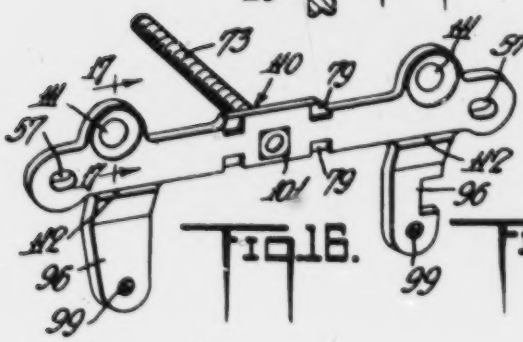

Fig. 16.

Fig. 11.

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UNIVERSAL MOUNTING FOR WINDSHIELD WIPER MOTORS

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Fig. 13.

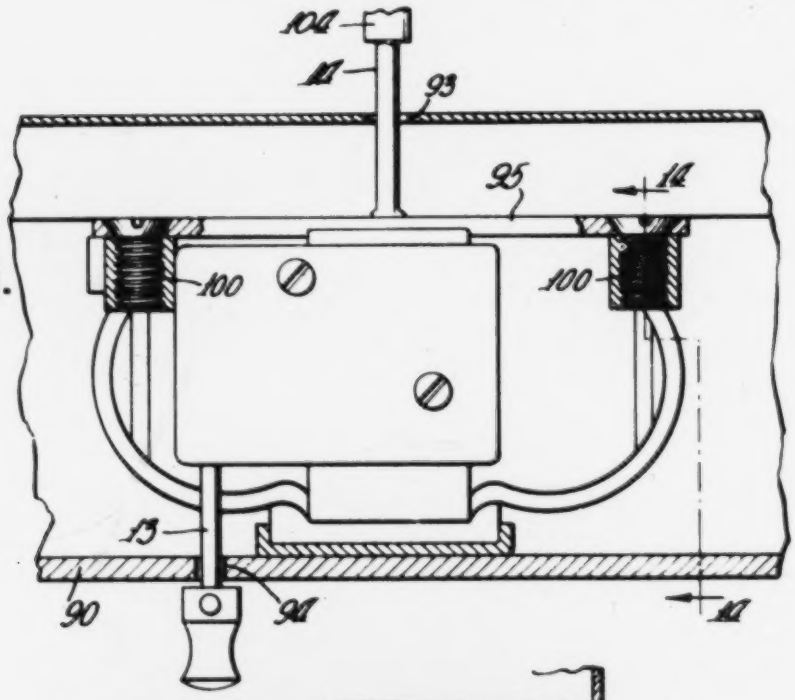


Fig. 14.

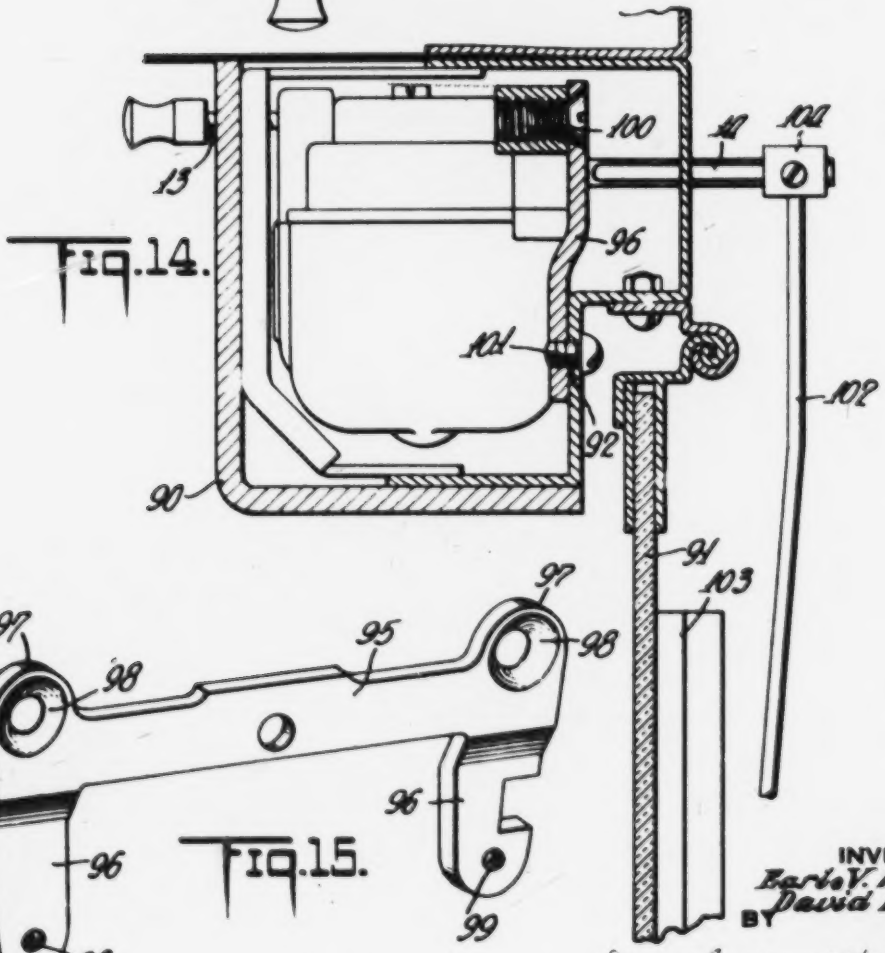
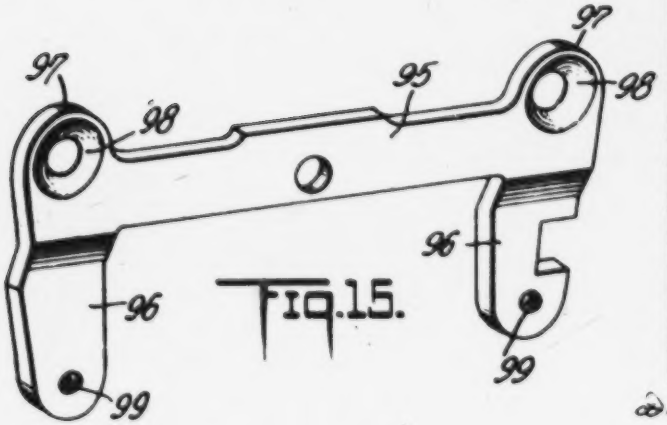


Fig. 15.



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Patented Nov. 2, 1937 2,097,662

UNITED STATES PATENT OFFICE

2,097,662

UNIVERSAL MOUNTING FOR WINDSHIELD WIPER MOTORS

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Application August 23, 1933, Serial No. 686,394
Renewed March 29, 1937

5 Claims. (Cl. 15—255)

Our present invention relates to means for conveniently mounting an auxiliary motor such for instance as a windshield wiper motor on or adjacent the windshield of a car.

Practically all cars and trucks are equipped at the factory with windshield wipers powered by an auxiliary motor of either of the electric or suction type, usually the latter. There has been no attempt to standardize windshields, windshield frames, header bars or other auxiliary wiper motor mounting apparatus by car manufacturers. The result has been that special types of motors and special types of mountings have been supplied to each car manufacturer. Some motors are mounted outside of the windshield, some are mounted inside of the windshield, some are concealed and some are not, the object of each manufacturer being to procure a motor and a motor mounting which will render the operating mechanism for the wiper as inconspicuous or as attractive or as cheap as possible while firmly securing it in position.

From the standpoint of the manufacturer who is turning out thousands of identical cars, such practice may be desirable but from the standpoint of the accessory dealer who is required to replace windshield wiper motors, the practice has proven highly undesirable since in order to completely supply the trade the dealer must carry in stock several score models and a complete line of wipers would involve stocking nearly two hundred different styles of motors to accommodate the trade if an exact duplicate of the worn or broken motor is to be used for replacement purposes.

Our present invention is primarily concerned with obviating this difficulty from the dealer's standpoint and with providing a motor which by means of a few simple adaptor attachments can be readily applied to nearly 100% of all of the automobiles now in use in the United States. Thus instead of stocking two hundred styles and types of motors, the dealer may stock a single standard motor and a few simple standard adaptor fixtures by which the motor may conveniently be applied to practically any make of car.

Another object of the invention is to accomplish this result while maintaining whatever standards may be set by the car manufacturers for concealed or inconspicuous motor mounts. Furthermore the cost of using our universal mounting arrangement is negligible as compared to the dealer's present costly practice of filling his shelves with dozens and dozens of motor types and still being unable to afford any proper mounting on certain types of cars.

Another object is to provide a set of adaptor fixtures, few in number, inexpensive in construction and capable of being so correlated with the motor and with the motor mounting part of the car, that expeditious and facile attachment of the motor may be readily accomplished.

Another object is to provide motor mounting means which while of simple construction, will be rugged, durable and efficient in use and which will afford a secure and if desired, a permanent mount for a windshield wiper motor.

While I prefer to apply the universal adaptor system to a light duty suction motor of the general character disclosed in Patent No. 1,912,777 issued to David Kuskin and Duncan A. McConnell on June 6, 1933, it is to be understood that similar adaptor systems might be used with various other types of suction or electric motors, notably the vane type and the piston type suction motors and the motion reversing or motor reversing types of electric motors.

Despite the great variation in the design of automobiles, if their windshield wiper motor mountings be considered independently of minute structural details of such mountings, they resolve themselves into but three types. (1) The outside motor mounting type where double support means must be provided for the motor at opposite sides of its wiper operating shaft and the shaft does not penetrate the windshield, header board or other part of the car but terminates between the motor and the outer face of the windshield or header board, and termed hereinafter for the sake of convenience, a two hole outside mount. (2) The most common type of inside motor mount wherein a single support means is provided for the center of the motor and the wiper operating shaft projects through this support means to move the wiper across the outer face of the windshield. With this type the support means is usually secured in the same opening through which the wiper driving shaft of the motor extends. It will be referred to hereinafter as a center hole mount. (3) An inside motor mount which corresponds in many particulars to the outside motor mount, that is to say, a mounting in which two anchorages or supports are afforded for the motor and the wiper operating shaft projects outwardly through the windshield frame or header board midway between the two motor anchorages. This type for descriptive convenience will be referred to hereinafter as a three hole inside mount.

Again waiving the details of such three general arrangements, it has always been considered essential to make the mounting means an integral part of the motor and to supply three separate types of motors for these three standard types of mountings. In addition to this, the mere fact that the mounting, anchoring or securing means for the motor always included parts which constituted an integral part of the motor, scores of variations of motor constructions have been resorted to, to meet the individual requirements of individual car manufacturers and individual car styles.

In accordance with the present invention we employ an adaptor system which will permit a standard motor to be quickly and conveniently and securely attached to a car using any of these three common types of motor securing, mounting or anchoring means or devices. While it is within the spirit of the invention to provide a single adaptor fixture, adapted with but minor variations to secure the motor in any of these standard mountings, we preferably employ a set of three primary adaptors, any of which may be selectively secured to the motor and conveniently anchored to or supported by the car without any alteration in the standard car construction. It will be understood that if the dealer prefers to keep the three main adaptor parts in stock rather than a single adaptor, it will not be necessary for him to stock any more adaptors than he stocks motors, but he can estimate the relative proportions of motors in use embodying the three general types of motor mountings and order his adaptors accordingly.

The convenience of such an arrangement to the tourist whose wiper is apt to break down hardly needs discussion. Suffice it to say that with this universal arrangement a tourist having a motor requiring replacement will be able to stop at even the smallest wayside dealer and procure a motor which will fit his car regardless of what type of car he may be driving and that such motor may be applied in but a few minutes.

It is within the scope of the invention to provide a single universal adaptor piece which is capable of being secured to the motor and to any motor support arrangement. In this case the main universal adaptor piece could be slightly trimmed off or unnecessary parts thereof removed if necessary or desirable before attaching the adaptor piece to the motor.

The invention may be more fully understood from the following description in connection with the accompanying drawings wherein:—

Fig. 1 is a view mainly in horizontal section taken through the header bar of a typical "General Motors" car such as a "Buick" utilizing a special type of three hole inside mount, and showing the manner in which one of the "Kuskin" type motors may be applied by a simple system of adaptors as a replacement for the type of motors used as standard equipment,

Figs. 2, 3 and 4 are perspective views of the adaptor fixtures,

Fig. 5 is a view similar to Fig. 1 but illustrating an adaptor arrangement for a typical standard two hole outside motor mount,

Fig. 6 is a front elevational view of the lower part of the motor and its adaptors taken on the line 6—6 of Fig. 5,

Fig. 7 is a sectional plan view showing the manner in which the motor may be applied to cars using a standard center hole inside mounting,

Fig. 8 is a perspective view of one member of the adaptor used with this mount,

Fig. 9 like Fig. 7 is a sectional plan view of another type of single hole mounting save that in this instance the motor shaft extends above instead of through the windshield frame and is secured partially by adaptor brackets,

Fig. 10 is a side elevational view of the motor mount shown in Fig. 9 and with the windshield and frame in section,

Fig. 11 is a perspective view of one of the brackets used in Fig. 10,

Fig. 12 is a perspective view of an auxiliary adaptor fixture used in the mounting shown in Fig. 10,

Fig. 13 is a sectional plan view showing how a motor can be mounted in concealed position within the header bar of a car, such mounting being typical of the standard "Essex" header bar construction and combining features of both the three hole and center hole inside mount,

Fig. 14 is a transverse sectional view on the line 14—14 of Fig. 13,

Fig. 15 is a perspective view of the adaptor bracket used in conjunction with this mounting,

Fig. 16 is a perspective view of a universal adaptor bar embodying all of the features of the bar shown in Figs. 6, 8 and 15, and

Fig. 17 is an enlarged transverse sectional detail on the line 17—17 of Fig. 16.

Referring first to Figs. 1 to 4 of the drawings, I have illustrated a standard windshield wiper motor of the general type illustrated in Patent No. 1,912,777 in greater detail in copending application of David Kuskin, Serial No. 671,969, filed May 20, 1933.

For purpose of the present disclosure it is sufficient to note that the motor includes a base casting 10 which mounts the parking mechanism on its under face, this parking mechanism being concealed by the dust cover 11 and including as an actuating element, a slide member indicated at 12 and at either end of which a handle 13 may be secured, this handle being push-pull control which regulates the main suction admitting valve. The motor mechanism itself is arranged upon or above the casting and is concealed by a dust cover 14 (Fig. 6).

The hollow header board construction illustrated in Fig. 1 is typical of the arrangement used in many "Buicks", "Chevrolets" and other types of "General Motors" cars where the motor has a variation of the "three hole inside mount" and drives either a single wiper or tandem wipers. The member which translates motion from our motor directly or indirectly to a wiper blade consists of a shaft 16c projecting laterally from one side of the casting. This shaft is oscillated by the motor and when the dealer receives it the shaft is quite long and is cut off by the dealer to the desired length in accordance with the particular type of car upon which the motor is to be mounted. Similarly the handle member 13 which is used for starting and stopping the motor is originally of excess length and is preferably of bendable metal so that it may either be cut off or in some instances bent into position for engagement by a supplemental actuating handle 69 (Fig. 5). Where said supplemental handles are used, the end of the member 13 is preferably provided with an eye 68 or some equivalent device for engagement attaching said handle.

The casting presents a pair of spaced ears 15 having internally threaded apertures 15a therein.

In some cases the holes need not extend entirely through the ears but threaded sockets are provided in lieu of the threaded apertures. These ears or sockets 15 constitute in every case the means by which the adaptor fixtures are secured to the motor.

In accordance with standard practice the hollow header bar 10 (Fig. 1) has secured thereunder a U-shaped bracket 17 and slidably mounted within this bracket is a push-pull bar 18, the ends of which are adapted to actuate one or two reciprocating or oscillating windshield wipers (not shown). Also mounted within the bracket and having one end accessible from the interior of the car is a transverse shaft 19 operating the push-pull bar 18 through the medium of a rocker arm 20 fixed upon the shaft 19 and pivotally connected to bar 18 as at 21. The inner plate or bar 22 of the header board is provided with a pair of openings 23 extending therethrough with a center opening 24 through which one end of the shaft 19 projects and a fourth opening 25 through which projects a nipple 26 connected interiorly of the header bar with a suction tube or pipe 27 and adapted to be externally connected with the main suction port 28. In the case of the particular type of motor here under discussion, the suction connection is made through an upstanding nipple 26 which lies closely adjacent to the dust cover 14 (Fig. 6).

With the exception of the motor the mechanism as thus far described, constitutes substantially the standard construction of the header board of this type of car. The use of a few simple adaptor fixtures permits the motor to be readily attached to the car as a replacement or as standard equipment.

In order to couple the shaft 19a to the shaft 19, we employ the adaptor illustrated in perspective in Fig. 4 and designated generally at 30. This adaptor includes a cylindrical portion 31 having a socket 32 therein adapted to be slipped over the shaft 19a and secured in place by set screw 33 working through the wall of the socket and preferably against a flat face 34 on the shaft 19a. Beyond the cylindrical socket portion 31, the adaptor 30 is externally tapered as at 35, this taper terminating in a squared extension 36 adapted to fit within the squared bifurcated end 37 of the shaft 19 and afford a keying and clutching connection between the shaft 19 and shaft 19a. The further reduced terminal end 38 of the adaptor 30 fits a socket 37a formed in the shaft 19 inwardly beyond the furcations 37.

A short length of flexible hose 39 bridges the space between the nipple 26 on the casting and the downwardly turned end of the nipple 26 which is attached to the car, such downwardly turned end being indicated in dotted lines at 40.

For supporting the motor casting and its associated parts we employ adaptor sockets 41 of the character shown in Fig. 3. The members 41 are externally cylindrical including reduced portions 42 defining annular external shoulders 43. Portions 42 are thrust home into the sockets 15 to an extent limited by the abutment of the shoulders 43 against the ends of the ears 15. Relatively long stud screws 44 extend outwardly through intermediate portions of the bracket 17 and through the apertures 23. Outward movement of the screws is limited by the engagement of their heads 45 with the intermediate portion of the channel plate 17 and the terminal ends of the screws screw into the internally threaded bores 46 of the adaptors 41. In order to limit the extent to which the stud screws may work into the adaptors 42, I employ spacer sleeves 47. These sleeves are preferably of an external diameter corresponding to the diameter of the ears 15. They each have a passage extending throughout their length which at one end is reduced as at 48 to correspond approximately in size with the shanks of the screws 44. These sleeves 47 extend through the openings 23 with one end abutting the bracket 17 and with the other end abutting the ears 15.

Inasmuch as this motor is mounted interiorly of the car, only a short handle member 13 need be provided for manual manipulation by the operator of the car. From the foregoing description it will be apparent that the problem of mounting one of the standard wipers herein illustrated in a car constructed in the manner illustrated in Fig. 1 may be expeditiously and easily accomplished and that when the motor mount has been effected, the motor will be firmly attached to the header board and the drive shaft will be effectively clutched to the shaft 19 which indirectly actuates the wiper actuating rod 18, the latter in turn oscillating or reciprocating a pair of tandem wipers (not shown) arranged beyond opposite ends of the wipers.

In Figs. 5 and 6 we have illustrated one of the standard wipers using a "two hole outside mount" secured by a simple adaptor mechanism to outside of header bar or the windshield frame. In this instance the motor is mounted outside of the windshield and the shaft end 19a extends inwardly from the motor toward the windshield terminating between the casting 16 and the windshield and the wiper blade (not shown) is carried directly by a suitable carrier member 50 fixed upon the end of the shaft 19a.

In this form of mounting a pair of screws 51 are used to attach an elongated flat stamped bar 52 upon the edge of the casting adjacent the windshield. The bar 52 is shaped to afford an opening or cut out 53 for the projecting control handle 54. It is also centrally apertured at 55 so that the shaft 19a may pass through it.

Preferably the openings in the bar through which the screws 51 pass are tapered at 56 to receive the screw heads and laterally beyond the opening which receive the screws, the extended ends of the bars are provided with apertures 57 therein adapted to receive bolts 58 for attaching the casting with its adaptor bar 52 to the windshield frame. This frame 59 is of tubular construction. It is provided with diametrically opposite apertures 60 through which the bolts 58 pass. Nuts 61 screwed onto the ends of the bolts press washers 62 against the apertured ends 57 of the bar 52, that is, the nuts are tightened to an extent limited by spacer sleeves 63 interposed between the ends of the adaptor bar and the frame 59.

Sleeves 63 are similar in construction to the sleeves 47 illustrated in Fig. 1 and may be of any desired length in accordance with the spacing required between the motor and the windshield. Such spacing must of course in any event be adequate to accommodate the shaft 14 which projects toward the windshield and carries the wiper arm.

In Fig. 6 there is disclosed a dust plate 64 pivotally secured as at 65 adjacent the opening 66 in the front of the casting through which the handle member for operating the parking device extends. Since this handle may be applied from

either side of the casting, the dust plate on the side opposite the handle is normally swung to closed position to block the entry of dirt and dust under the dust cover 11. Fig. 5 also illustrates the manner in which a supplemental handle device may be employed in conjunction with the parking control mechanism. Here a short handle 64 having an eye 68 screws into the slide 12. The exact alignment of this handle with the handle 69 in the windshield frame is rendered unnecessary by making the eye of relatively large size and drilling a hole in the frame through which the supplemental handle 69 projects, said handle having a bent end which engages in the eye 68. It will be observed from Figs. 5 and 6 that the knob 70 with the handle 69 is disposed within the car so that the driver may have convenient access to it when starting or stopping the wiper actuating motor.

It will be readily apparent that the spacer sleeves 47 and 53 might be supplied in any length desired or that long sleeves might be shortened or that the sleeves might all be made of maximum length and transversely severed by the dealer to shorten them when shorter sleeves are required. The walls of these sleeves which encircle the enlarged portions of their bores are quite thin. Furthermore, the sleeves themselves are preferably made of some soft metal so that they could be quickly cut through with a hacksaw if desired. It will be apparent that Fig. 5, like Fig. 1, illustrates an adaptor structure including parts to be anchored to the ears 15 and parts secured by the anchored element for attaching the motor at or adjacent the frame of the windshield.

Figs. 7 and 8 show an extremely simple adaptor arrangement to be used where the motor is mounted inside of the car and only a center hole mount for the motor is required. With this form of the invention, screws 71 corresponding to screws 51 of Fig. 5, serve to secure a flat, elongated adaptor bar 72 to the edge of the casting 10. The adaptor bar in this instance carries at its center a laterally projecting hollow externally threaded sleeve 73. This sleeve is adapted to pass through aligned apertures 74 in the windshield frame 75. The shaft 19a extends through the sleeve 73 and outwardly beyond the sleeve mounts the wiper arm carrier 76. In order to clamp the adaptor bar 72 which is rigid with the casting, against the inside of the windshield frame it is merely necessary to screw a nut 77 onto the projecting end of the sleeve 73, a plate or washer 78 being preferably interposed between the nut and the outer face of the frame 75.

It will be observed that the adaptor bar near the center thereof is punched at a plurality of points to provide projections 80 on one face of the bar and corresponding recesses 79 at the other face of the bar. In Fig. 8 I have shown four of these punched out portions arranged in generally rectangular formation so that projecting portions may bite into the windshield frame and check any tendency for the motor to turn about its center hole mounting.

Here again the adaptor structure includes a device attached to the cars 15 and means associated with such device for securing the motor structure to the frame. Many methods might be employed for attaching the sleeve 73 to the adaptor bar 72. By observing the cross sectional shape of the center hole in the adaptor bar in Fig. 9 together with the showing of Fig. 10, it will be seen that the adaptor bar has an opening therethrough which is of increased diameter near one face of the bar. This increase in diameter may be effected by making the hole conical or by forming an enlargement in one end thereof. In either event the end of the sleeve 73 is spun over into interlocked relationship with the shoulder thus formed so that it is restrained against outward movement. With the adaptor bar in place of course, the casting itself blocks axial movement of the sleeve in the opposite direction. An advantage of having an enlarged opening of irregular shape is the fact that when the sleeve is spun or pressed out into engagement with the bar, it will be positively blocked against rotary as well as endwise movement in no one direction. In order to prevent disassembly of the sleeve and adaptor bar 72, it should be noted that a shoulder 85 defined by the reduced end of the sleeve abuts the outer face of the bar 72 to prevent the sleeve from being pushed all of the way through the bar in the opposite endwise direction.

The sleeve is of internal diameter exceeding the external diameter of the shaft and there is no danger of the shaft coming into contact with the interior of the sleeve due to the rigid mounting of the sleeve carrying bar 72 with respect to the casting 10 which in turn is fixed with respect to the oscillating shaft 14.

Figs. 9 to 12 inclusive show an adaptor mechanism which is in all respects identical with that of Fig. 7 save that the threaded sleeve 73 instead of extending through a hole in the windshield frame, extends above the windshield frame and passes through openings 82 in a pair of identical complementary bracket members 83 which embrace opposite sides of the frame bar 75 and have their upper ends 84 pressed tightly together as an incident of tightening the nut 77. The lower portion of the brackets may be shaped identically with the cross section of the windshield wiper bar or may, as shown in the illustrated embodiment of the invention, be bent to define opposed concave surfaces 84 which will accommodate practically any type of windshield frame bar.

It will be understood of course that the brackets 83 may be made of various shapes in order to snugly grip windshield frames of special cross sectional shapes. However the brackets which are illustrated here will in most instances afford an adequately effective gripping action.

Rectangular spacer plates 81, one of which is shown in perspective in Fig. 11 may be used between the innermost bracket and the adaptor bar 72 to space the motor inwardly far enough to clear the bulge in the bracket. Since the punched out and recessed portions of these plates correspond exactly to the punched out and recessed portions of the bar 72, one or more of the plates may be interposed between the adaptor bar 72 and the windshield frame 75 and nest snugly with each other and the adaptor bar. No matter how many plates are introduced, they are always interlocked with each other and through the bar 72 with the motor in such fashion that there can be no independent rotation of the plates. One of the plates or if no plates are used, the adaptor bar itself affords a relatively substantial bearing surface against the inside of the windshield frame to prevent localized deformation of the latter when the nut 77 is screwed tightly home.

The sleeve 73 may be severed at any point along this length to expose the end of the shaft 14, in accordance with the particular thickness of the windshield frame upon which the device is mounted.

Center hole mountings of the type illustrated in

Figs. 7 and 10 are typical of the method by which windshield wiper motors are secured to closed and open "Ford" cars.

Similarly with the type of mounting illustrated in Fig. 6 the best operation is obtained by spacing the shaft end a very definite distance from the windshield. With this form of the invention the shaft end is somewhat longer than the short shaft of Fig. 1 and the second saw guide mark shows exactly where the shaft would be cut when the motor is to be mounted as disclosed in Fig. 6 and by the use of the adaptors of Fig. 6.

In Figs. 13 to 15 we have shown another extremely simple type of adaptor construction designed to meet the similar peculiar requirements of standard "Essex" cars. With this type of mounting, the motor itself is completely concealed within the hollow header bar of cross bar 90 which is disposed within the car, adjacent and above the windshield 91. The problem here is to devise a set of adaptors which will permit the motor to be mounted in the restricted space afforded by the header bar design and without the need for providing any apertures other than those which are standard with this type of construction.

The lower portion of the hollow header piece is somewhat narrower than the upper portion and is set back from the windshield and it is ordinarily provided with a pair of openings 92 in its front face through which securing screws for a wiper motor are adapted to pass. Another aperture 93 is customarily provided in the front wall of the header piece above the windshield and through this opening the oscillating wiper shaft is adapted to project. A fourth opening 94 arranged near the top of the rear wall of the hollow header piece is adapted to provide clearance for movement of the control handle. This is another modification of the three hole inside mount.

The adaptor which we use includes a flat transverse bar illustrated in perspective in Fig. 15 and designated by the numeral 95. The ends of this bar are integrally connected with a pair of parallel leg portions 96, these legs extending slightly above the bar and a considerable distance below it. In the upper generally circular leg extensions 97 we provide counter sunk openings 98 and in the lower extremities of the legs we provide threaded apertures 99.

Screws 100 corresponding to the screws 71 of Fig. 9 and the screws 51 of Fig. 6 serve to attach the adaptor bar 95 to the motor, such screws passing through the openings 98 into the sockets 15 and having their heads accommodated in the countersinks of openings 98. The lower ends of the legs of the adaptor are then attached to the hollow header piece by screws 101 which are passed through apertures 92 and screwed into the apertures 99, thus rigidly supporting the motor structure in inverted position.

With the motor in this position the shaft 14 projects outwardly through the opening 93 and the arm 102 for the squilgee 103 may be attached to the projecting end of the shaft 14 in any convenient or conventional manner as for instance by the coupling 104. A control handle 13 corresponding to that of Fig. 1, passes through the opening 94.

From the foregoing it will be apparent that by the use of a single adaptor bracket and a couple of screws, the motor may be conveniently secured in concealed position within the header member without making any alterations in the header member itself.

We have referred to the handle 13 and corresponding elements throughout the specification as controlling a starting valve. With the particular type of motor illustrated in the pending application of Kuskin, above identified, such handle also controls the parking of the wiper blade as fully disclosed in application Serial No. 671,980 above identified but only as an incident of operation of the main control valve of the motor.

A careful analysis of the various types of mountings illustrated herein will disclose that in every instance the mounting means includes an adaptor secured directly to the motor casting and means for in turn securing the adaptor structure itself to the particular part of the car from which the motor is to be supported. In every instance the adaptor structure consists essentially of two elements which are attached or rigidly held with respect to each other, either integrally or separately and with one of those elements removably secured to the motor and the other of the elements removably secured to the car

As suggested in the preamble to the specification, the purchase of a few of these simple adaptor forms will permit a dealer to apply a new windshield wiper motor to practically any standard type of car construction and without in any event necessitating the alteration of the car itself. In no instance is it even necessary to drill a special hole or in any way alter the standard construction of the car itself. From the standpoint of the dealer, a motor mechanism which is universally adapted for convenient application to practically any type of car, will entirely eliminate the need for stocking tremendous numbers of different types of motors and the cost of the adaptors themselves is but negligible as compared to the expense involved in purchasing and installing large stocks of wipers of many different styles upon which the dealer in most cases makes a very slow turn-over.

Referring to the adaptor shown in Fig. 16 it will be noted that it embodies in composite form, all of the structure of the adaptor of Figs. 6, 8 and 15. That is to say, this universal adaptor designated generally at 110, embodies legs 96 of the adaptor shown in Fig. 15 together with their screw holes 99. It also embodies the screw 73 shown in the adaptor of Fig. 8 and likewise the notches 78 shown in that figure. It furthermore embodies the projecting portions with their apertures 57 as illustrated in the adaptor of Fig. 6 and also mounting holes for mounting it on the casting. These holes are designated at 111 and they occupy the identical same position as the mounting openings of Figs. 6, 8 and 15. In connection with this universal adaptor it will be noted that the mounting holes of Fig. 5 are countersunk as at 56 from one face of the adaptor bar and the mounting holes of Fig. 15 are countersunk from the opposite face. With the universal adaptor bar of Fig. 16 we countersink both faces of the mounting hole as indicated at 113 (Fig. 17) thereby permitting countersinking or partial countersinking of the head of the screw regardless of which way the screw extends through the mounting openings 111.

The only portions of this universal adaptor which may prove unsightly with certain types of mounting are the legs 96 and preferably these legs are notched or weakened as indicated at 112. These notches appear at the point of juncture between the legs and the main adaptor bar

and when the legs do not form a necessary part of the mounting they may be broken off by simply bending them back and forth.

Of course in addition to the desirability in some instances of breaking off the legs, it will frequently prove necessary to remove the screw 13. This screw may be conveniently removed by grasping it with a pair of pliers and pulling it out of its mounting hole, the metal of the hollow screw being soft enough so that the screw may be readily withdrawn. It will be understood of course that this metal, when the adaptor is in actual use, carries no substantial strain and there is no danger of inadvertently dislodging the screw if the universal adaptor of Fig. 16 is to form part of a center hole mount.

It will thus be seen that there is herein described apparatus in which the several features of this invention are embodied, and which apparatus in its action attains the various objects of the invention and is well suited to meet the requirements of practical use.

As many changes could be made in the above construction, and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:—

1. The combination with a windshield wiper motor including a pair of spaced hollow members to receive adaptor devices and including a driven shaft projecting from the motor between said members, of adaptor devices for securing said motor in operative position on or adjacent interiorly or exteriorly of the windshield frame or other mounting member, which affords either a single hole mount or a double hole mount, said adaptor devices including adaptor means to pass through the mounting hole or holes of the windshield frame or other mounting member and complementary adaptor means comprising a flat bar lying against the motor rigidly connected to said first adaptor means and to the spaced hollow members of the motor, said bar bridging the space between said hollow members and cut away to afford clearance for said shaft.

2. The combination with a windshield wiper motor having a pair of spaced internally threaded members adapted to receive mounting parts, of adaptor means for securing said motor upon a car adjacent the windshield thereof, said adaptor means including a bar, means engageable with the threaded members and bar for holding the bar and motor together, means associated with the bar for anchorage on or adjacent the windshield frame, the intermediate part of said bar having portions punched out to afford notches in one face of the bar and projections on another face of the bar to a correspondingly notched spacer plate adapted for nesting with the notches or projections of the bar and space the motor at the desired distance from the windshield.

3. The combination with a windshield wiper motor including a wiper actuating shaft and a pair of spaced internally threaded members adapted to receive mounting parts and disposed at opposite sides of said shaft, of adaptor means for securing said motor upon a car adjacent the windshield thereof, said adaptor means including a bar, means engageable with the threaded members and bar for holding the bar in position with respect to the motor, means associated with the bar for anchorage on or adjacent the windshield frame and including a pair of brackets adapted to embrace the windshield frame, said brackets including upwardly projecting portions having aligned apertures therein through which the wiper actuating shaft projects, an externally threaded sleeve fixed to the bar encircling the shaft and passing through the aligned apertures in the brackets and a nut engaging said sleeve for clamping the brackets on the windshield frame.

4. The combination with a windshield wiper motor including a pair of spaced hollow members to receive mounting fixtures and including a driven shaft projecting from the motor between said mounting fixtures, adaptor means for securing the motor in operative position on or adjacent to a windshield frame, said means including an adaptor bar, screws attaching the adaptor bar to the openings, a hollow externally threaded screw fixed to the bar encircling the shaft and adapted to pass through an opening in or adjacent the windshield frame, and of less length than the shaft, a nut for securing the screw in position, spacer means adapted for interposition between the bar and the windshield frame, said spacer means and said bar having nesting projections and recesses to prevent turning of the spacer with respect to the bar.

5. The combination with a windshield wiper motor including a pair of spaced hollow members to receive mounting fixtures and including a driven shaft projecting from the motor between said mounting fixtures, of a motor supporting adaptor bar, screws entering the hollow members and securing the adaptor bar to the motor, means for securing the adaptor bar in operative position on or adjacent a windshield frame, a concealed starting valve for the motor, said motor having openings therein at opposite sides thereof through which a valve handle is adapted to be selectively attached to the valve, said adaptor bar being cut away to expose the openings through which said handle is attached.

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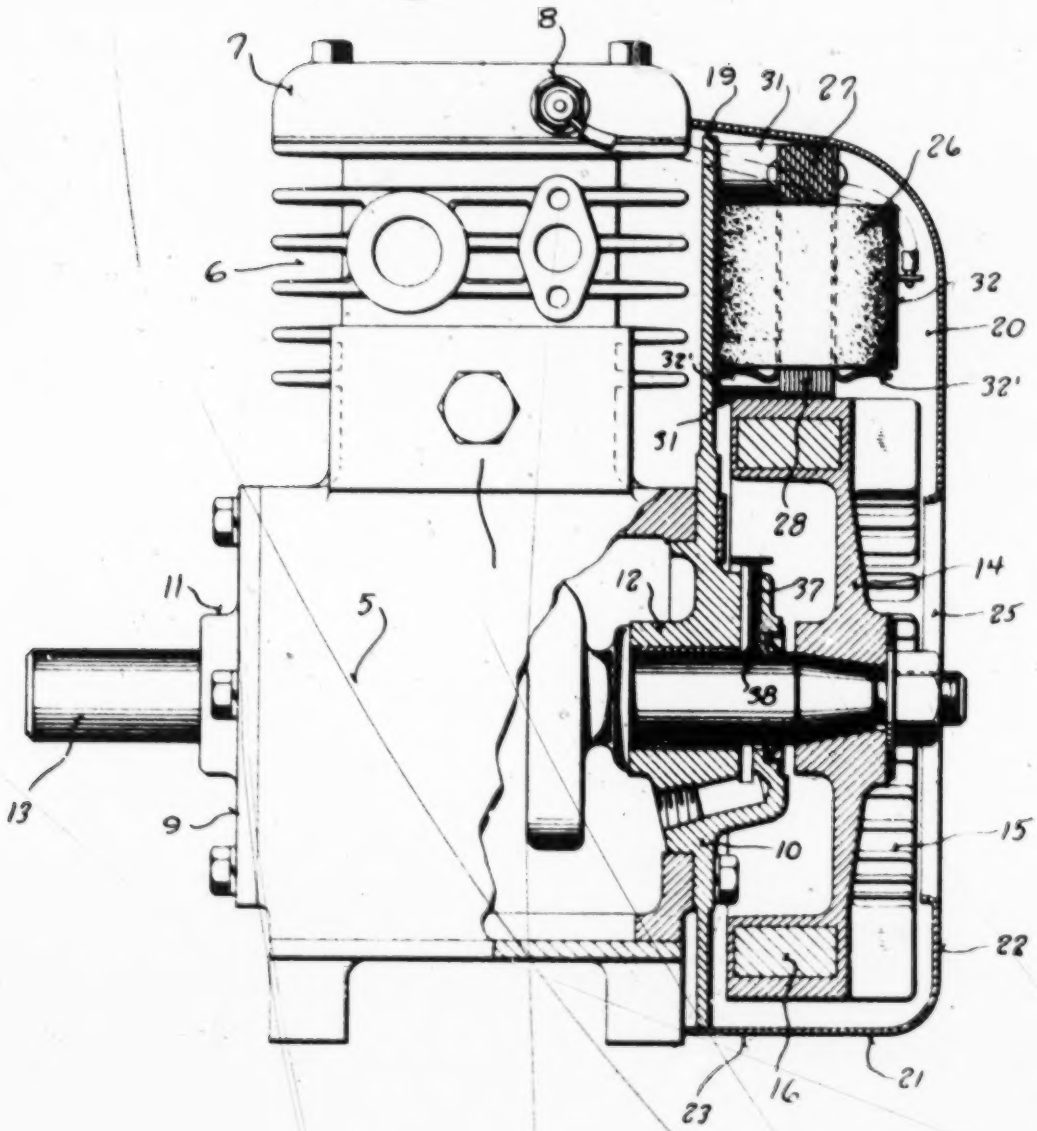
May 9, 1939. E. N. JACOBI 2,157,666

FLYWHEEL MAGNETO ASSEMBLY FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 16, 1936 2 Sheets-Sheet 1

Fig. 1.



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FLYWHEEL MAGNETO ASSEMBLY FOR INTERNAL COMBUSTION ENGINE

Filed Sept 16 1936 2 Sheets-Sheet 1

Fig. 2.

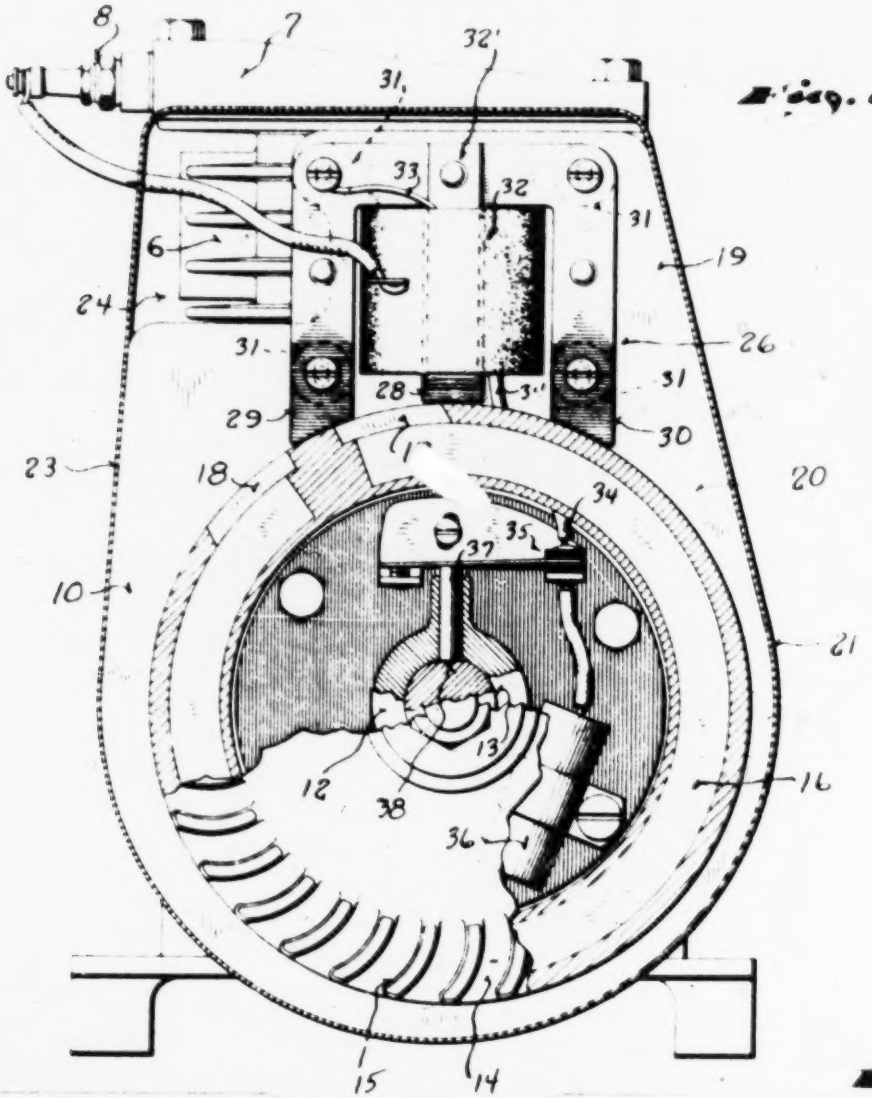


Fig. 3.

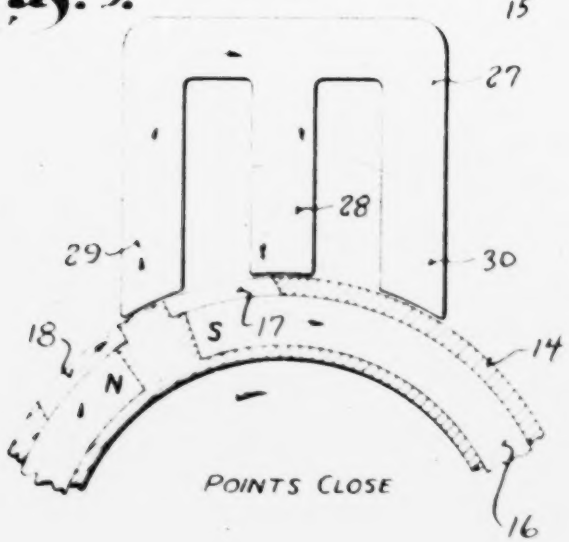
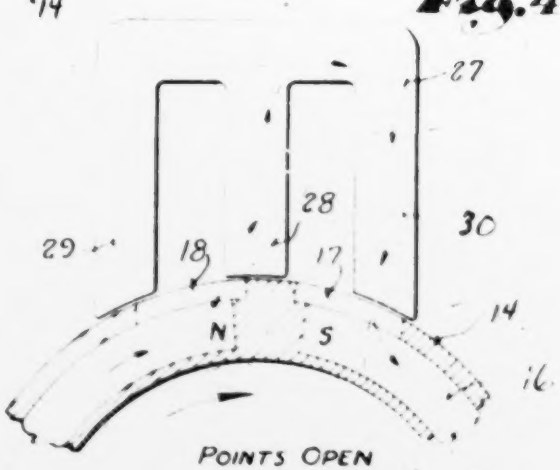


Fig. 4.



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Patented May 9, 1939

2,157,666

UNITED STATES PATENT OFFICE

2,157,666

FLYWHEEL MAGNETO ASSEMBLY FOR INTERNAL COMBUSTION ENGINES

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REISSUED

DEC 3 1 1940

Application September 16, 1936, Serial No. 101,125

2 Claims. (Cl. 123—149)

This invention relates to improvements in internal combustion engines and refers particularly to the magneto assemblies therefor.

It is an object of this invention to provide an improved magneto of the fly-wheel type whereby the size of the fly-wheel carried ring magnet may be proportioned to the magnetic requirements without regard for other factors.

It is another object of this invention to provide a magneto assembly of the fly-wheel type in which the coil and its armature core are mounted wholly outside the fly-wheel.

Another object of this invention is to provide a magneto assembly of the character described in which the coil and its core are so located as to be cooled by the air flow induced by the fly-wheel impeller so that efficient heat dissipation is obtained with a minimum use of copper and iron.

It is also an object of this invention to provide a magneto assembly which so disposes its ignition coil that the lead to the spark plug is exceptionally short.

Another object of this invention is to provide a magneto assembly wherein a quick reversal is obtained in the direction of flux flowing through the armature core upon which the coil is mounted.

More specifically, it is an object of this invention to provide a magneto assembly wherein a three legged armature core is employed whose dimensions are such with respect to the poles of the ring magnet as to insure a very rapid change in the direction of flux flowing in the center leg upon which the coil is mounted.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate a complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a side view of an internal combustion engine with parts broken away and in section showing this invention;

Figure 2 is an end view of the engine with parts broken away and in section; and

Figures 3 and 4 are detail views showing the manner in which the direction of flux is abruptly changed.

Referring now particularly to the accompanying drawings, in which like numerals indicate like parts throughout the several views, the numeral 5 designates the crank case of a small portable combustion engine upon which a cylinder 6 is mounted. Ordinarily, the cylinder and the crank case are cast in one unit. The top of the cylinder is closed by a cylinder head 7 in which a spark plug 8 is secured. One end of the crank case is closed by a plate 9 and its opposite end is closed by a mounting plate 10. The plates 9 and 10 have crank shaft bearings 11 and 12, respectively, in which the crank shaft 13 of the engine is journaled.

Outwardly of the mounting plate 10 the crank shaft mounts a fly-wheel 14, on the outer face of which is an air impeller 15 to induce a flow of cooling air as hereinafter more fully described. Imbedded in the fly-wheel is a permanent ring magnet 16 having pole pieces 17 and 18 spaced apart a short distance and exposed at the outer periphery of the wheel.

The lower portion of the mounting plate is circular and substantially co-extensive in size with the fly-wheel. Its upper portion is extended tangentially to provide an extension 19 alongside the cylinder 6 and reaching up to the head 7.

The mounting plate with its upward extension 19 forms the inner wall of a blower housing and air guide 20, the other walls of which are formed by a stamped metal hood 21 which has a flat outer wall 22 of a size and shape roughly co-extensive with that of the mounting plate, and integral side walls 23 which extend inwardly to engage the peripheral edge of the mounting plate at all portions except one upper corner. This corner of the plate is cut away as at 24 to define an outlet for the cooling air induced to flow through the housing by the impeller 15. The opening 24 is so located that the air issuing therefrom impinges the cylinder 6.

An inlet opening 25 to the blower housing and air guide 20 is formed in the outer wall 22 opposite the center of the air impeller 15. Consequently, air is drawn in through the opening 25 and blown out through the opening 24.

In the space within the housing 20 above the fly-wheel and alongside the outlet opening 24 so as to be located in the direct path of the cooling air is a magneto assembly indicated gen-

erally by the numeral 26. The assembly 26 comprises a three legged armature core 27 having a center leg 28 and side legs 29 and 30. The core, as is customary, is preferably laminated and is mounted by posts 31 on the outer face of the mounting plate extension 19 in a position with the lower curved end faces of its three legs 28, 29, and 30 lying in an arc concentric to and slightly spaced from the outer periphery of the fly-wheel. Consequently, the pole pieces 17 and 18 successively sweep past the legs 29, 28, and 30 to induce a magnetic flux which is abruptly and rapidly reversed in direction through the center leg 28.

Mounted on the center leg is a conventional induction coil 32 having a primary and secondary. The coil is slipped onto the center leg 28 where it is held by spring retaining member 32'. Inasmuch as the three legs of the core are parallel and lie sufficiently close together so as to obviate the necessity for inwardly projecting horns on the outer legs 29 and 30, assembly of the coil core onto the core is a simple matter as it slides freely onto and off of the center leg.

To obtain correct air gaps between the magnet poles 18 and 17 and the coil core poles 28, 29, and 30, it is only necessary to slide the coil core downward against feeler gauges held between the coil core poles and the flywheel periphery, and with the coil core held in this manner tighten its fastening screws.

One end of the primary and seconary of the coil is grounded as at 33. The other end of the secondary is connected through the customary high tension lead with the spark plug; and the other end of the primary is connected through a conductor 34 with an insulated terminal 35 of a circuit breaker. The other terminal of the circuit breaker is grounded and is also connected to a condenser 36 in the customary manner. The circuit breaker is adapted to be actuated by a pusher pin 37, which rides on the crank shaft in line with a flattened portion 38 so that the pin is permitted to descend and allow closure of the circuit breaker once each revolution.

It is to be observed that all of the instrumentalities of the magneto are mounted on the outer face of the mounting plate where they are readily accessible, especially the coil and its armature core. It is also to be noted that this disposition of the coil and its core locates the same at a substantial elevation above the base where it is more likely to be clean and free from oil, and being mounted outside the flywheel and in position to be impinged by the cooling air, adequate heat dissipation is obtained with a minimum use of copper and iron.

In this respect it is to be observed that the coil and its core are so mounted on the plate 19 as to lie alongside or adjacent to the side of the main air stream issuing from the blower and passing to the outlet opening 24. One side of the coil core thus forms a guide or wall extending along one side of the main air stream so as to be cooled directly thereby. It is also to be observed that the curved bottom wall and tangential side wall of the blower housing, together with the coil defines substantially a scroll casing for the centrifugal impeller, and while the main air stream flows through this casing between the coil core and adjacent side wall of the housing to issue from the opening 24 and directly impinge the valves which are at the hottest portion of the engine, other lesser air streams flow through and over the coil and also past the other side of the coil core to impinge the cylinder head.

Moreover, being mounted near the top of the mounting plate near the cylinder head, the high tension lead to the spark plug may be exceptionally short.

Another advantage of the present construction resides in the fact that the mounting plates besides carrying the magneto assembly also forms one wall of the blower housing air guide, thus reducing the number of parts; and with the coil and its core mounted outside the fly-wheel, the size of the ring magnet can be proportioned to the magnetic requirements without regard for the necessity of enclosing a bulky coil. This permits making the flywheel smaller in diameter and in turn allows the engine to be built much lower than in past constructions, as the fly-wheel when proportioned to the requirements of the length of the magnet bar needed for permanence is much smaller and much more economical of the material both in the magnet and in fly-wheel proper than in a construction where the size of the flywheel is determined by mechanism which it must enclose. Also, of particular importance is the fact that a three legged armature core is employed, for through its use a more efficient magnetic machine is obtained.

As will be readily apparent particularly from Figures 3 and 4, the flux through the center leg 28 reverses abruptly and rapidly as the pole pieces 17 and 18 sweep past the pole faces of the three legs. Being close together and mounted exteriorly of the fly-wheel adjacent to its periphery, the three legs of the armature core are swept by the magnet poles in a small annular movement to thus further assure rapidity in the change in direction of the magnetic flux through the center leg 28 and consequently the coil.

In this respect, attention is directed to the fact that the arcuate length of the two magnet pole pieces 17 and 18 is sufficient to span the distance between adjacent legs of the armature core and that the space between the pole pieces 17 and 18 is less than or at least not greater than the arcuate length of the pole face of the center leg 28. This dimensional relationship is responsible for the exceptional rapidity of the change in direction of flux for as will be readily apparent from Figures 3 and 4, the flux flowing in one direction (Figure 3) hangs on and continues to flow in this direction until the very instant that the flux begins to flow in the opposite direction (Figure 4).

From the foregoing description taken in connection with the accompanying drawings, it will be readily apparent to those skilled in the art, that this invention provides an exceptionally compact and magnetically efficient magneto assembly for small portable internal combustion engines.

What I claim as my invention is:

1. In a magneto assembly for an internal combustion engine having a crankcase, a crankshaft and a cylinder mounted on the crankcase, a plate closing one side of the crankcase and having a part projecting alongside the cylinder, a bearing on the plate for the crankshaft, magneto parts carried by the plate adjacent to the bearing, a hollow flywheel mounted on the crankshaft and cooperating with the plate to enclose the magneto parts, a permanent magnet carried by the flywheel and having poles facing the exterior of the flywheel rim, and an armature coil core mounted on the side of the plate opposite the cylinder so that the plate constitutes a heat barrier

between the cylinder and the armature coil core, said core having limbs providing poles in close juxtaposition to the path of the magnet poles to be swept thereby as the flywheel revolves.

2. A magneto assembly for an internal combustion engine having a crankcase with a crankshaft therein and a cylinder mounted on the crankcase, a flywheel on the crankshaft having its side which faces the crankcase hollowed to provide a cavity, a permanent magnet carried by the flywheel with its poles facing the exterior of the flywheel rim, magneto parts inside the flywheel cavity including a circuit breaker for the magneto primary circuit, a cam rotatable with the crankshaft, a pusher pin operable by the cam to actuate the circuit breaker, an armature coil core having spaced limbs providing poles adapted to be swept by the poles of the permanent magnet, a plate closing the crankcase and the cavity formed by the hollow of the fly-wheel and having bores providing bearings for the crankshaft and the pusher pin and extending beyond the rim of the flywheel alongside the cylinder to provide a heat barrier between the cylinder and the armature coil core, and means for mounting the core on said extending portion of the plate.

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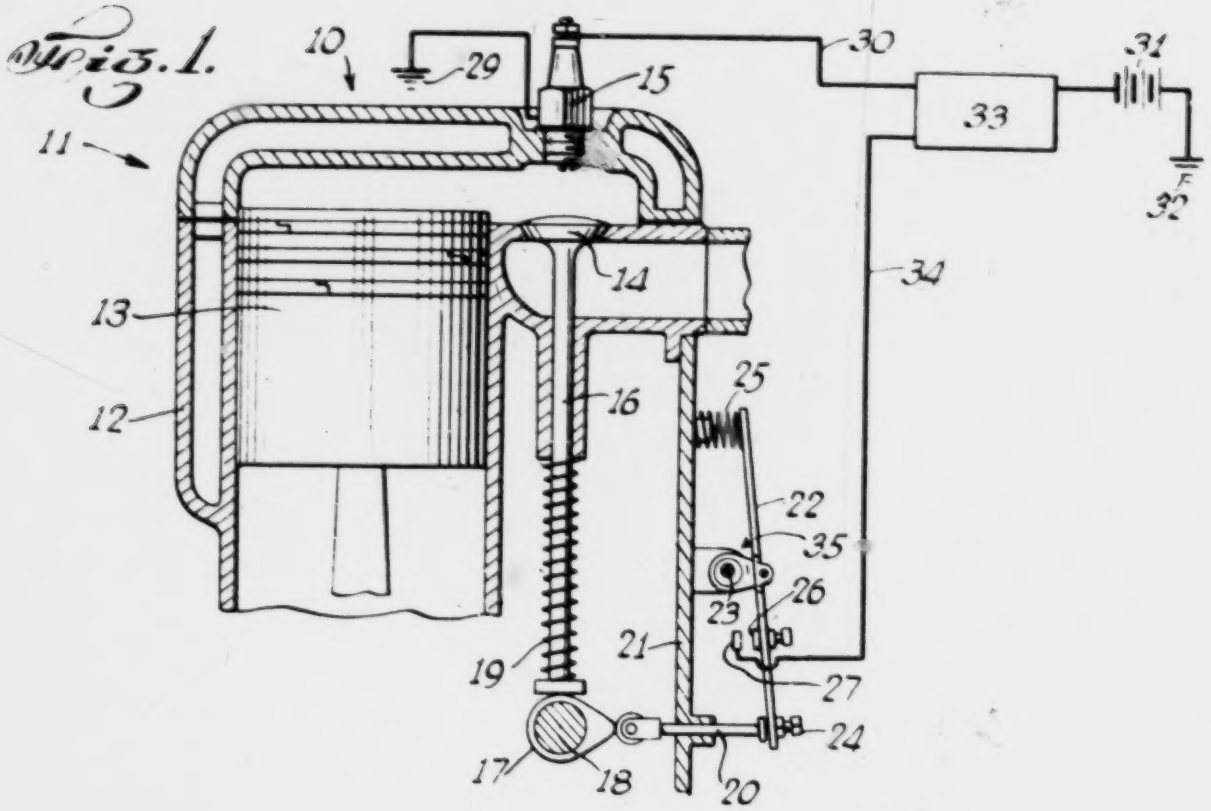
Sept. 17, 1940. A. LEFEBVRE 2,215,106

IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed Sept. 16, 1939

Fig. 1.



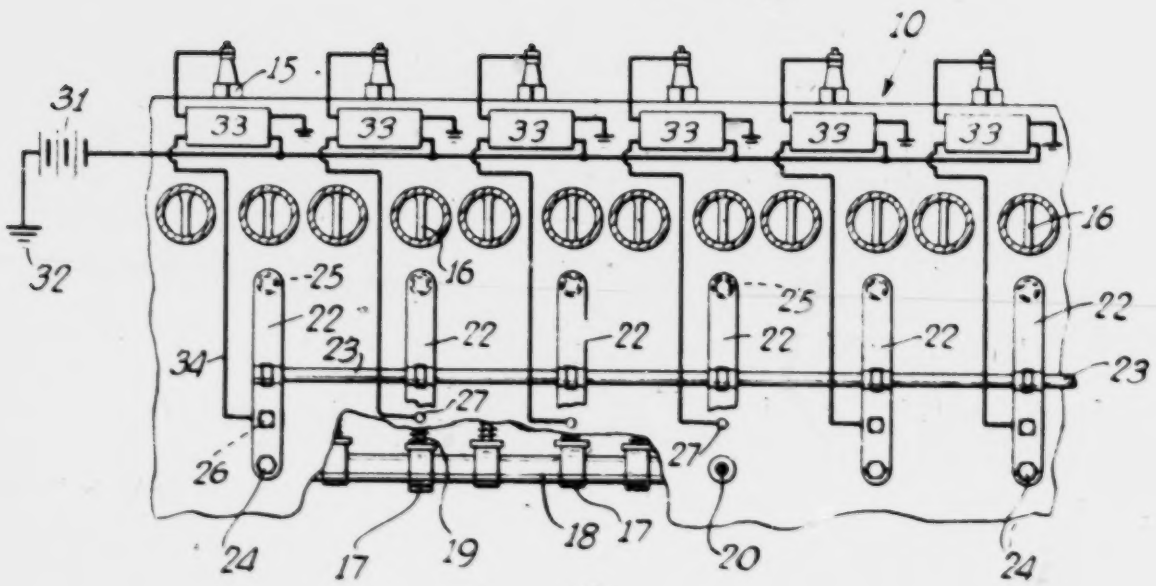


Fig. 2.

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Patented Sept. 17, 1940 2,215,106

UNITED STATES PATENT OFFICE

2,215,106

IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Application September 16, 1939, Serial No. 295,196

7 Claims. (Cl. 123—146.5)

This invention relates to ignition systems for internal combustion engines of the type adapted for high speed operation.

One object of the invention is to provide such an ignition system wherein the sparking switch shall not be subject to the effects of fatigue or lag as in the high speed switches now in use.

I have perceived that when the internal combustion engine is operated at a high range of speed, the combustible mixture may fail to be properly ignited in certain cylinders of the usual multi-cylinder engine. This condition is not confined to a particular cylinder, but would haphazardly occur first in one and then in another of the cylinders. The indications were that there was either entire or partial failure of a sufficient arc across the spark plug electrodes. These results I traced to the operation of the multi-switch unit or "distributor" which controls the current supply to the different spark plugs. Such unit is provided with a single spring contact arm which upon rotation engages successive contacts for the different spark plugs. Upon further study, I perceived that this spring contact is subjected to bending strains at such high speed and in such extremely rapid succession as to fail to establish proper engagement with each of its companion contacts, so that the lack of ignition or "skipping" heretofore referred to occurs.

The invention therefore aims to provide improved means whereby a sparking switch shall operate at high rapidity, and with the period of its successive operations being nevertheless greatly reduced. In other words, in a six cylinder motor, for example, the switch shall operate only once for each complete cycle of a cylinder, to thus afford a movable contact of actuator spring an opportunity for properly returning to normal position without the effects of lag or fatigue which heretofore resulted.

A further object of the invention is the provision of a device of the nature set forth having few and simple parts, and which is inexpensive to manufacture, install, and adjust, and which shall be free of missing or skipping and avoid backfire while affording maximum speed and power especially in motors of high capacity, and which shall be durable, reliable, and efficient in use.

Other objects and advantages of the invention will become apparent as the specification proceeds.

With the aforesaid objects in veiw, the invention consists in the novel combinations and arrangements of parts hereinafter described in their preferred embodiments, pointed out in the subjoined claims, and illustrated in the annexed drawing, wherein like parts are designated by the same reference characters throughout the several views.

In the drawing:

Figure 1 is a diagrammatic cross sectional view of an internal combustion engine, with an ignition system according to the invention applied thereto.

Fig. 2 is a fragmentary schematic side view of a multi-cylinder engine with the ignition system applied thereto, generally in accordance with the view of Fig. 1.

The advantages of the invention as here outlined are best realized when all of its features and instrumentalities are combined in one and the same structure, but, useful devices may be produced embodying less than the whole.

It will be obvious to those skilled in the art to which the invention appertains, that the same may be incorporated in several different constructions. The accompanyng drawing, therefore, is submitted merely as showing the preferred exemplification of the invention.

Referring in detail to the drawing, 10 denotes a device embodying the invention. The same may include an internal combustion engine 11 that may comprise a plurality of motors, as, for example, six or any other desired number. Each motor may have a piston 13, and a valve means 14, a spark plug 15 being provided for a combustion chamber of any desired arrangement. According to conventional practise, the valve means 14, which may represent preferably an exhaust valve, may have a slide rod 16 engageable by a cam 17 of a cam shaft 18. An expansion coil spring 19 may tend to move the valve stem into engagement with its cam 17. Each motor will thus have two cams on the cam shaft 18, one for the exhaust and one for the inlet valve, and each of the series of motors 12 will have its individual cams on the cam shaft, all in accordance with well known practise.

The ignition system according to the invention may include switches for the individual motors 12, each switch operated in response to a valve cam of its motor. Thus assuming a six cylinder engine, there will be six switches, all alike, except that each is timed according to its particular cylinder or motor.

More particularly, the cam 17 may actuate a follower rod 20 slidably mounted in a supporting member or wall 21 of the engine. This follower 20 may engage a contact or switch member 22,

which may be pivotally mounted at 23. At one end, the member 22 may carry an adjustable set screw 24 for engagement with the follower 20. At its other end, an expansion coil spring 25 may act between the member 22 and the motor block so as to move the member 22 into constant engagement with its cam follower 20. Carried by the member 22 is a contact 26 engageable with a fixed contact 27 which may be grounded to the motor block. Likewise the one terminal of the spark plug 15 may be grounded at 28. From the other terminal thereof extends a conductor 29 to the circuit of the fixed contact 27. A source of electrical current 31, grounded at 32, feeds current to a transformer and condenser unit 33, schematically shown, and which by a like showing is connected at 34 to the contact 27.

In operation, the spring 25 tends to move the member 22 to close the sparking switch 26, 27. When the cam 17 moves to the position shown, it moves the rod 20 toward the right, causing oscillation of the member 22 and opening the switch 26, 27. The break of the branch circuit through the switch 26, 27 causes a flow of current which produces an arc across the spark plug electrodes. It will be understood that the circuit herein shown is merely illustrative, and that any well known circuit may be substituted therefor, and that the invention does not depend on the characteristics of any particular circuit. A unit including a sparking switch 26, 27 and transformer and condenser elements therefor as above described is provided for each of the cylinders of the engine 11. It will be perceived that since the sparking switch is operated from the cam shaft, no accidental change in timing is possible. By utilizing valve cams 17, the need for extra cams is dispensed with. Also the troublesome distributor gear at present in use is eliminated.

If it be desired to advance or retard the spark, a common adjustment for the switches 26, 27 of all of the cylinders may include a rod 23 which forms the pivot hereinbefore mentioned and which is provided with a series of rotary eccentrics 35. In other words, each sparking switch may have its own eccentric. By giving the rod 23 a slight turn in one or in an opposite direction the members 22 are all bodily moved toward the right or toward the left. Individual adjustment for the sparking switches is afforded by the set screws 24.

It will be readily appreciated that the switch 26, 27 represents any suitable type capable of rapid operation, and that the switch will be operated only once for each cycle of its motor. Thus if the engine 11 has six cylinders, each switch will be operated only one sixth as many times as the switch of the distributor now in use. This affords ample time intervals for the switch to rest and avoid fatigue and lag, with consequent skipping or missing at high speeds. Hence still higher motor speeds are available, and uniformly more power and higher motor efficiency will be obtained because all the fuel in the cylinders will be fired; and the even balancing of the motor crank shaft will be maintained to minimise vibration. Nor can any accidental change so affect the time of firing as to cause backfire, since the timing is that caused directly by the cam shaft. These advantages are especially striking with very powerful motors of the types used in tractors, large trucks and aircraft. While a single transformer and condenser unit could be used with all of the sparking switches, it is for certain purposes advantageous to provide a separate such unit for each switch. Thus inspection and repair is greatly facilitated, and if a circuit for one cylinder should for any reason fail, the other cylinders will continue to operate to prevent stalling of the vehicle.

I claim:

1. An ignition system for an internal combustion engine comprising a multi-cylinder motor having a cam shaft for the valves thereof, and means for causing sparks across the electrodes at the different cylinders, including individual switches for the different cylinders, each switch having a plurality of contacts separate of those of the other switches, and individual means operated by the cam shaft for separately actuating the different switches, common means for adjusting all the switches to advance or retard the sparking action, and means for individually adjusting the switches to advance or retard the sparking action, said common means including an adjustable shaft, each switch having a switch arm for a contact, and eccentric mounted on the adjustable shaft for moving the individual switch arms upon manually turning the shaft in one or in an opposite direction.

2. A device including a multi-cylinder internal combustion engine comprising a shaft having cams for individually actuating the exhaust valves of the different cylinders, individual electrical switches for the spark plugs of the different cylinders, and means to control said switches comprising elements for the respective switches individually actuated by the different cams, said elements being wholly separate and independent of said valves and constituting followers in direct engagement with the cams so that said switches are operated at accurately timed intervals irrespective of any retardation or sticking of the valves.

3. A device including a multi cylinder internal combustion engine comprising a shaft having cams for individually actuating the exhaust valves of the different cylinders, individual electrical switches for the spark plugs of the different cylinders, and means to control said switches comprising elements for the respective switches individually actuated and the different switches being disposed in direct juxtaposition to their corresponding cylinders with the said elements extending from the cams directly to their respective switches at right angles to said shaft.

4. A device including a multi cylinder internal combustion engine comprising a shaft having cams for individually actuating the exhaust valves of the different cylinders, individual electrical switches for the spark plugs of the different cylinders, and means to control said switches comprising elements for the respective switches individually actuated by the different cams, said means also comprising individual springs for the different switches to oppose said elements, said means being wholly separate and independent of said valves with said elements constituting followers in direct engagement with the cams for causing accurately timed operation of the switches irrespective of the valve response to the cams, said motor having a wall for mounting said switches and said springs, guide means for the said elements carried by said wall, said elements being rods longitudinally slidably carried by the guide means and extending from the cams directly to their respective switches at right angle to said shaft.

5. A device including a multi cylinder internal combustion engine comprising a shaft having

cams for individually actuating the exhaust valves of the different cylinders, individual electrical switches for the spark plugs of the different cylinders, and means to control said switches comprising elements for the respective switches individually actuated by the different cams, said elements being wholly separate and independent of said valves and constituting followers in direct engagement with the cams so that said switches are operated at accurately timed intervals irrespective of any retardation or sticking of the valves, each switch having a swingable arm for opening and closing the switch, and means for mounting said arms comprising eccentric means and a common shaft for the different arms, said shaft having fixed bearings and being rotatable relative to said arms, and the shaft and eccentric means coacting with each other so that an angular movement of said shaft bodily moves all of said arms to thus advance or retard the timing of all the switches by a single adjusting movement.

6. A device including a multi cylinder internal combustion engine comprising a shaft having cams for individually actuating the exhaust valves of the different cylinders, individual electrical switches for the spark plugs of the different cylinders, and means to control said switches comprising elements for the respective switches individually actuated by the different cams, said elements being wholly separate and independent of said valves and constituting followers in direct engagement with the cams so that said switches are operated at accurately timed intervals irrespective of any retardation or sticking of the valves, said switches having a first series of contacts and a second series of contact for opening and closing of the switches, a common shaft for mounting one of said series of switches, fixed bearings for said shaft and eccentrics for said shaft coacting therewith so that a turning movement of the shaft causes a variation in gaps between the contacts for advancing or retarding the timing of the switches.

7. A device including a multi cylinder internal combustion engine having individual switches for the spark plugs of the different cylinders, each switch having a first contact and a second contact, a lever for the second contact, a spring for each lever tending to move the same in one direction, elements operated by a cam shaft for the cylinder exhaust valves for causing individual movement of the levers in an opposite direction, a common shaft for pivotally mounting the different levers, fixed bearings for said shaft, and eccentrics for the shaft cooperating with the lever so that an angular turn of the shaft causes bodily movement of the levers relative to the first contacts for advancing or retarding the timing of all the switches.

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INTERNAL COMBUSTION ENGINE

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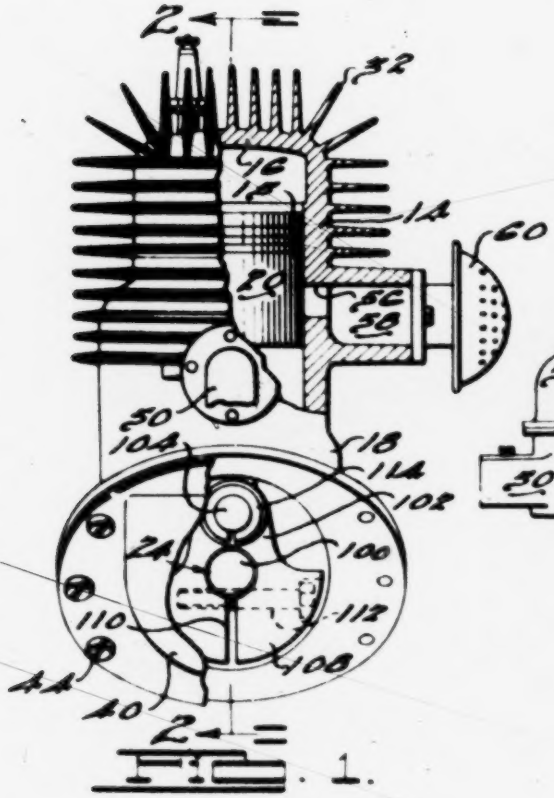

FIG. 1.

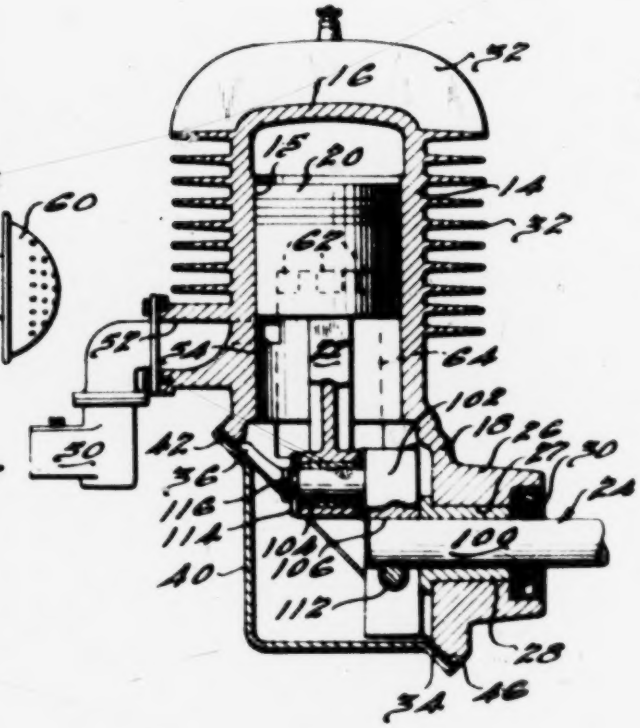

FIG. 2.

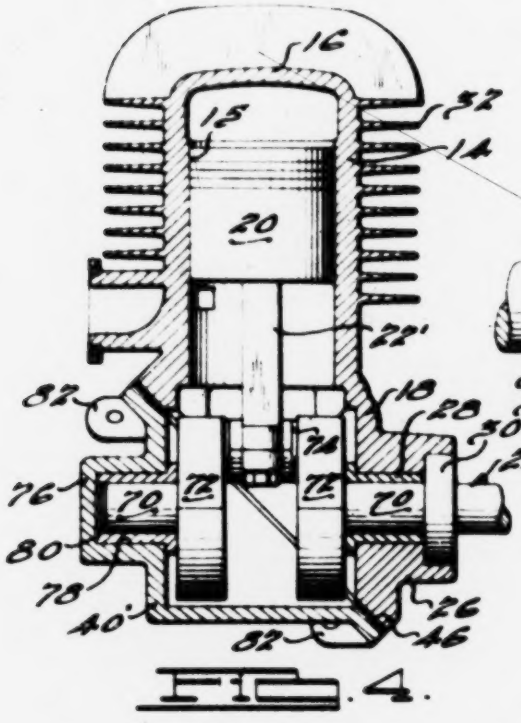

FIG. 4.

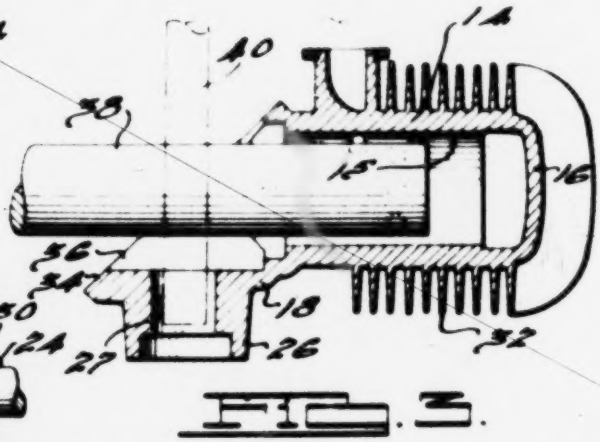

FIG. 3.

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INTERNAL COMBUSTION ENGINE

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FIG. 5.

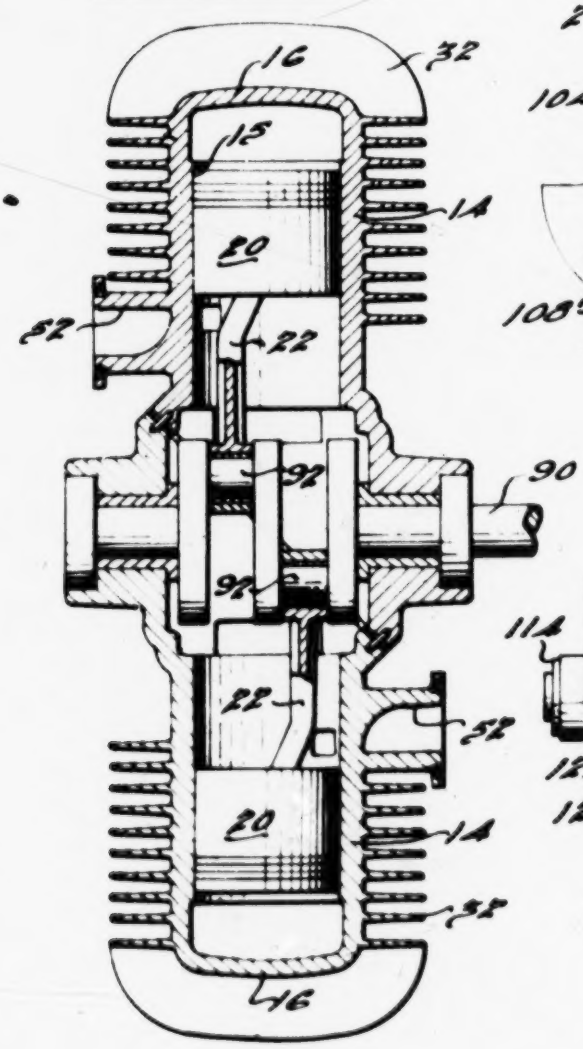


FIG. 6.

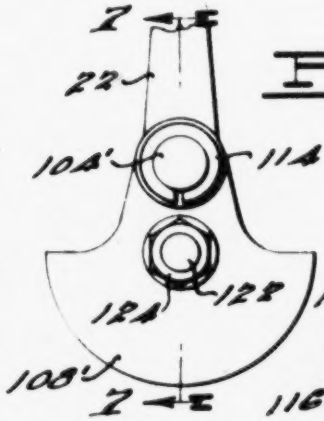


FIG. 7.

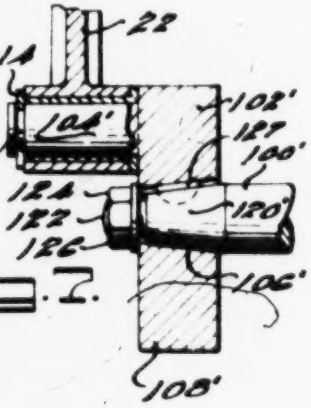


FIG. 8.

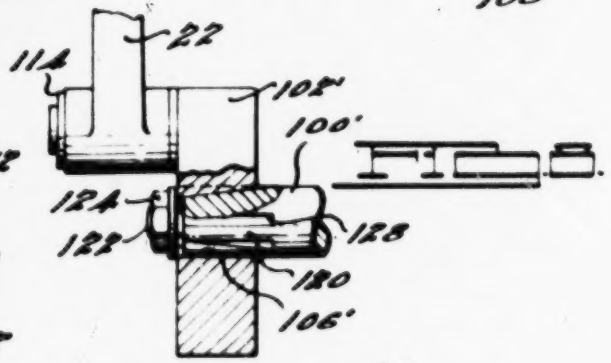


FIG. 10.

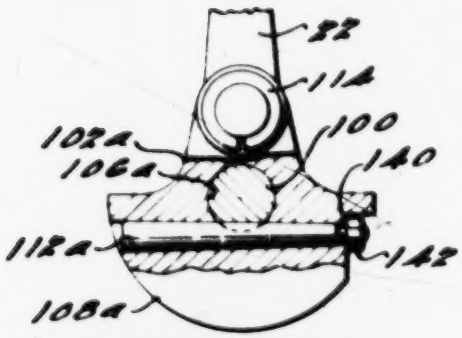
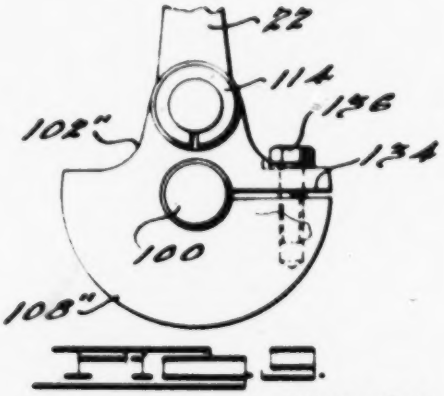


FIG. 9.



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UNITED STATES PATENT OFFICE

2,218,332

INTERNAL COMBUSTION ENGINE

Leonard E. Fowler, Detroit, Mich.

Application April 10, 1939, Serial No. 266,933

10 Claims. (Cl. 123—195)

This invention relates to internal combustion engines, pumps, compressors or the like and has for its principal object the provision of a construction of simplified form producing marked economies in manufacture. Reference will be made herein only to the application of the invention to internal combustion engines, this for the purpose of simplicity in description, and the application of the invention to other like uses will thus be made clear to those skilled in the art.

Other objects of the invention include the provision of an internal combustion engine having a cylinder and at least a part of the crankcase thereof formed integrally with each other, the crankcase portion having an open side through which tools may be inserted to machine the interior of the cylinder for reception of a piston and the crankcase for reception or formation of the crankshaft bearings therein; the provision of an internal combustion engine including a cylinder and a crankcase portion formed integrally therewith, the crankcase portion being provided with a face extending at an angle to both the axis of the cylinder and to the axis of the crank shaft and having an opening in such face whereby to permit the insertion of tools into the bore of the cylinder and into the crankcase for effecting a machining operation upon the same; the provision of an internal combustion engine having a cylinder provided with an integral cylinder head and crankcase portion, the crankcase portion adapted to rotatably support a crank shaft disposed at right angles to the axis of the cylinder, the crankcase having a planular face disposed at an angle to both the axis of the crank shaft and to the cylinder axis providing an opening leading into the crankcase through which tools may be inserted to machine both the bore of the cylinder and the crankshaft bearing receiving portion of the crankcase, means being provided for effecting a closure of the opening for normal engine operating conditions; the provision of a construction as above described in which the means for closing the opening in the crankcase also serves to provide means for supporting an additional bearing for the crank shaft; and the provision of an internal combustion engine as above described in which complementary cylinder and crankcase portions are arranged in opposed relationship with the crankcase portions cooperating with one another to close the corresponding mentioned openings.

Other objects of the invention include the provision of an internal combustion engine having a crankcase face directed at an angle to the axis of both the crank shaft and the cooperating cylinder, the cylinder being provided with a piston connected by means of a connecting rod to the crank shaft, the throw of the crank shaft being removable with respect to the crank shaft proper whereby to permit the use of unsplit large ends on the connecting rods, and the provision of an engine crank shaft for an internal combustion engine including separately formed throw portions removably secured to the crank shaft in a novel manner.

The above being among the objects of the present invention the same consists in certain novel features of construction and combinations of parts to be hereinafter described with reference to the accompanying drawings, and then claimed, having the above and other objects in view.

In the accompanying drawings which illustrate suitable embodiments of the present invention and in which like numerals refer to like parts throughout the several different views,

Fig. 1 is a partially broken, partially sectioned end elevational view of an internal combustion engine constructed in accordance with the present invention;

Fig. 2 is a vertical sectional view of the engine shown in Fig. 1 taken on the line 2—2 thereof;

Fig. 3 is a sectional view of the cylinder and integrally connected crankcase part of the engine shown in Fig. 2, and taken in the same plane as Fig. 2, illustrating the manner in which the cylinder bore and the crank shaft bearing receiving bore may be machined by tools passing through the one opening in the crankcase;

Fig. 4 is a view similar to Fig. 2 but illustrating a modified form of construction in which the crank shaft is provided with two bearings instead of one;

Fig. 5 is a view similar to Fig. 2 but illustrating the use of the cylinder and crankcase combination illustrated in Fig. 2 in duplicate to provide a two cylinder opposed engine;

Fig. 6 is a partially broken front end elevational view of a modified crank shaft construction, illustrating a connecting rod shown in broken view operatively associated therewith;

Fig. 7 is a vertical sectional view taken on the line 7—7 of Fig. 6;

Fig. 8 is a view similar to Fig. 7 but illustrating a modified construction for securing a throw on the end of the crank shaft;

Fig. 9 is a view similar to Fig. 6 but illustrating a modified form of construction; and

Fig. 10 is a view similar to Figs. 6 and 9, but partially broken, and illustrating a further modi-

fied construction for securing a throw on the end of a crank shaft.

The present invention has for its principal object the provision of a simple and economical construction for the cylinders and crankcase portions of internal combustion engines which will not only simplify the foundry practices and costs in connection with the same but will facilitate the principal machining operation thereon. In other words the present invention is directed to a construction which will render the manufacture of certain types of internal combustion engines considerably more economical than is possible with conventional types of constructions and this without detracting from the desired qualities of rigidity and efficiency required in such engines for long life operation.

The present invention is applicable for use in connection with internal combustion engines of either the two or four stroke principles, Diesel engines or any other type of engine including a crank shaft and a piston reciprocable along an axis at substantially right angles thereto. Because of its nature it will usually find greater application in engines of the smaller sizes and to engines of the single or double opposed cylinder type although it will not be necessarily restricted to these types in all cases. Because of the simplicity of the construction of the conventional form of two cycle engines employing a carburetted mixture, this particular type of engine has been selected for the purpose of illustrating the present invention in the accompanying drawings, the showing in this respect being illustrative and not limiting.

Referring now to the accompanying drawings and particularly to Figs. 1, 2 and 3, an internal combustion engine is shown comprising a cylinder 14 provided with a bore 15, an integral cylinder head 16, and an integral crankcase portion 18. The bore 15 of the cylinder 14 is interiorly provided with a conventional piston 20, reciprocable therein, connected in a conventional manner by means of a connecting rod 22 to a crank shaft indicated generally at 24. The crank shaft 24 is rotatably supported in the crankcase 18 with its axis arranged perpendicularly to the axis of the cylinder 14 through the medium of an integral axial extension 26 on the crankcase 18. Although the extension 26 may be of any suitable length and contain any suitable or desirable number of bearing elements arranged in adjacent or suitably axially spaced relationship for rotatably supporting the crank shaft 24, the extension 26 is shown by way of illustration as having a bore 27 containing a single bearing bushing 28 for rotatably supporting the crank shaft 24. Preferably the outer end of the bore 27 is provided with a conventional oil seal element 30 for preventing the escape of lubricant from the interior of the engine along the crank shaft.

The cylinder 14 may, of course, be cooled in any suitable or conventional manner but for the purpose of illustration in the present case it is shown as of the air cooled type and, accordingly, as being provided with a plurality of cooling fins 32 for dissipating the heat from the cylinder 14 to the surrounding air.

The important feature of the present invention is that the crankcase or crankcase portion 18 is provided with a planular face 34 which extends at an angle to both the axis of the crank shaft 24 and the axis of the cylinder 14. The angularity of the face 34 may vary from that shown in order to satisfy the desires of the particular designer, but preferably it is disposed at an angle of 45° to the axis of the cylinder and crank shaft as shown in the drawings. The face 34 is provided with an opening 36 therein through which the full extent of the bore 15 of the cylinder 14 and the full extent of the bore 27 for the bearing bushing 28 in the extension 26 is viewable axially of such bores. As illustrated in Fig. 3 this feature permits a boring or other tool such as 38 to be introduced into the bore 15 of the cylinder 14 axially thereof for the purpose of machining or otherwise finishing such bore, and also permits a boring or other tool such as 40 to also be introduced through the opening 36, but, of course, at a time when the boring tool 38 is not in operative position, to bore the hole 27 for the bushing bearing 28, or an equivalent bore for receiving the crank shaft if no bearing bushing or the like is to be employed.

The above described feature permits the combined cylinder 14, cylinder head 16 and crank case portion 18, forming an integral unitary structure, to be mounted in a suitable machine tool and permit both the bore 15 of the cylinder 14 and the hole 27 to be machined without requiring shifting of the unit in any respect whatever. The construction thus permits a single set up for boring both the bore 15 of the cylinder and the hole 27, consequently reduces the cost of machining these bores as compared to conventional practices, and materially simplifies the accurate location and angularity of one with respect to the other. Additionally it will be observed that because of the angular face 34 and the relatively large opening leading into the bore of the cylinder and the interior of the crankcase, it facilitates the casting of the unit in the foundry, permits a secure support for the various cores required, and thus permits the cores to be maintained in their proper position during the pouring operation and in fact is such as to permit the use of a green sand core for forming the bore of the cylinder and the interior of the crankcase under certain circumstances. Thus it will be observed that because of the provision of the angular face 34 with the relatively large opening 36 therein both the casting and the machining of the unit is considerably simplified and rendered materially more economical than is possible with conventional constructions, resulting in a product that is considerably less expensive to manufacture and sell and yet one that suffers no loss from rigidity or efficiency because of these economies.

Where the crankcase 34 is provided with a single throw, the opening 36 will be closed by a simple pan-like structure 60 closing the opening 36 and having marginal flanges 62 complementary to the marginal portions of the face 34 and suitably secured thereto as by screws or bolts 64 with the preferable interposition of a suitable gasket 66. The closure 60 is thus of a nature similar to the conventional oil pans employed on internal combustion engines and, as will be appreciated, may be formed of either a stamping or a casting. It will, of course, be observed that the pan-like closure 60 is of a sufficient size to permit the necessary rotation of the crank shaft and lower end of the connecting rod 22 therein but where the engine is of a two cycle type, as in the case illustrated, it will usually be desirable to maintain the volume of the crankcase including that of the pan 60 at a minimum figure, while in the case of a four-cycle engine or of a Diesel type engine this volume is not of such great importance and it may be made of sufficient size to hold the usual supply of lubricating oil or the like

as will be appreciated by those skilled in the art.

It may be noted that in the particular engine shown, it being of a two-cycle type, it is provided with a conventional carburetor 80 which communicates with an intake passage 82 formed in the lower portion of the cylinder 14 and connected into the bore 16 of the cylinder 14 through a plurality of ports 84 which are uncovered by the piston 20 as the latter approaches the upper limit of its compression stroke. Thus the piston in moving outwardly in the cylinder 14 creates a partial suction in the crankcase 18 and as soon as the piston 20 uncovers the port 84 this partial suction is relieved by a flow of combustible mixture through the carburetor 80, passage 82 and ports 84 into the crankcase. As the piston 20 moves downwardly after the crankcase has thus been filled with a combustible mixture through the ports 84, it first closes the ports 84 to the escape of combustible mixture therethrough and continued downward movement compresses the combustible mixture in the crankcase and lower part of the cylinder, and as the piston approaches its bottom dead center position it first uncovers the exhaust port 86 which permits the escape of exhaust gases outwardly therethrough into the passage 86 and through a muffler such as 88 to the atmosphere. Shortly after the piston 20 uncovers the exhaust ports 86 in its downward movement it uncovers the inlet ports 92 in the opposite sides of the cylinder and illustrated in dotted lines in Fig. 2. The inlet ports 92 are connected by a passage 94 with the interior of the crankcase 18 adjacent the lower end of the cylinder 14 so that as the ports 92 are uncovered by the piston 20 the combustible mixture compressed in the crankcase is permitted to flow up into the cylinder 14 where it is compressed and exploded on the following stroke.

Where it is desired to use a crank shaft having a journal on opposite sides of the crank pin thereof, then resort may be had to the construction illustrated in Fig. 4. It will be observed that in this case the crank shaft 24' is provided with spaced journals 70, spaced throws 72 and a crank pin 74, all formed integrally with one another in accordance with conventional practice, and the journal 70 is rotatably supported in the bearing bushing 28 as in the previously described construction. However in this case, instead of employing the pan member 40 described in connection with Figs. 1 and 2, a modified form thereof indicated at 40' is employed in its place. In this case the closure member 40' is preferably of cast construction and is provided with an axial extension 76 interiorly provided with a blind bore 78 receiving a bearing bushing 80 for receiving the remaining journal 70. The closure member 40' is, of course, secured to the integral cylinder and crankcase unit in the same manner as the previously described closure 40 and is sealed thereto by means of an equivalent gasket 46. In Fig. 4 the closure member 40' is illustrated as being provided with a plurality of apertured lugs 82 which may be employed as a mounting means for the engine if desired.

Where it is desired to construct a two cylinder opposed engine, the same general effect as obtained in Fig. 4 may be obtained but without the use of a closure member additional to the crankcase and cylinder units themselves. As illustrated in Fig. 4 a pair of units identical to those illustrated in the previous views and each including a cylinder 14, cylinder head 16 and crankcase portion 18 are arranged in opposed relation and with the angular faces 34 thereof in opposed contacting relation with respect to each other and suitably secured together in such a position. Inasmuch as this requires one of the cylinders to be turned 180° with respect to the other it provides spaced journals for the crank shaft 98 and each of the units serves as a closure for the opposite unit. In this case where the engine is of the two stroke type, the crank shaft 96 is necessarily provided with a pair of crank pins 97 spaced angularly from one another by 180°, one piston 20 being connected to a corresponding crank pin. It will be observed that the feature of providing the angular face on the integral cylinder and crankcase portion of the present invention thus admirably adapts it to use as either a single or a double opposed cylinder engine.

Referring now to the construction shown in Figs. 1 and 2 it will be appreciated that if the large end of the connecting rod 22 is not of a split character it is impossible to use a crank shaft in which the throw and the crank pin are formed integrally therewith for in such case it would be impossible to either assemble or disassemble the structure. The crank shaft may be of an integral construction if the big end of the connecting rod is of a conventional split character embodying a removable cap or lower half. Where the big end of the connecting rod is not of a split character, it is then necessary to make either the throw, the crank pin or both removable from the main portion of the crank shaft. This latter construction is shown as forming one feature of the present invention and resulting in a construction more economical to manufacture than one requiring a split bearing on the connecting rod as well as effecting certain economies where the engine is employed to drive certain other devices and particularly where a part of such other device is built upon the crank shaft.

Accordingly, in the construction illustrated in Figs. 1 and 2 the crank shaft 24 comprises a separately formed cylindrical part 100 serving to provide the main journal of the crank shaft and through which the engine may be connected to some driven device. The throw 102 and the crank pin 104 are preferably formed integrally with one another but separately of the part 100. The throw 102 is provided with a hole or bore 106 therein in which the corresponding end of the shaft 100 is closely received. The throw 102 is formed to provide the usual counterweight 108 thereon for counterbalancing the weight of the piston 20 and part of the connecting rod 22 and the counterweight portion is centrally split as at 110 into the bore 106. A bolt or screw 112 is extended through the counterweight portion 108 as best illustrated in Fig. 1 across the line of split 110 and in partially intersecting relation with respect to the end of the shaft 100 received in the bore 106. The intersecting relation of the screw 112 with the shaft 110 serves as a key to positively prevent relative rotation of the throw 102 with respect to the shaft 100 and by tightening up the screw 112 it contracts the wall of the opening 106 about the end of the shaft 100 to rigidly secure the same in place. The screw or bolt 112 is readily accessible through the opening 36 after the pan 40 has been removed and this permits ready assemblage and dis-assemblage of the crank shaft. In assembling the piston, connecting rod and crank shaft in the engine, the connecting rod 22 is connected to the piston 20 in the conventional manner by means of a wrist pin (not shown) the

crank pin 104 is inserted in the large end of the connecting rod, the piston is inserted into the bore 15, and then the shaft 100 is introduced into place and is then forced into the bore 106 of the throw 102 after which the screw 112 is inserted and tightened up. In some instances it may be desirable to provide some means on the free end of the crank pin 104 to prevent possible axial movement of the big end of the connecting rod 22 thereon. While any suitable means may be provided for this purpose the particular means shown comprises a split washer 114 which is sprung into a groove 116 formed in the outer end of the crank pin 104 immediately outwardly of the corresponding end of the connecting rod big end as best brought out in Fig. 2.

In the construction illustrated in Fig. 4, the throws of the crank shaft and the crank pin are all integral with one another and in such case it is necessary to provide the big end of the connecting rod 22' with a removable cap in accordance with conventional practice. The crank shaft shown in Fig. 5 also includes throws and pins formed integrally with the main portion of the shaft and consequently requires the connecting rods to be provided with removable end caps for the purpose of assembly and dis-assembly.

In Figs. 6 and 7 a modification of the type of crank shaft construction as shown in Figs. 1 and 2 is illustrated and which, accordingly, permits the use of an unsplit big end for the connecting rod 22. In this case the crank pin is illustrated at 104' and identical in construction to the crank pin 104 previously described. The throw 102' is similar to the throw 102 previously described and is provided with a similar counterweight 103'. In this case, however, the counterbalance portion 103' is not split but instead the corresponding end of the shaft 100' is tapered as at 120 and its extreme end portion is formed to provide a short stud 122 thereon. The bore 106' in the throw 102' in this case is formed for complementary reception of the tapered end 120 of the shaft 100' and it is maintained securely in place thereon by means of a nut 124 threaded on the stud 122 in conjunction with a washer 126. A key 127 is employed between the tapered end 120 and the throw 102' to positively prevent relative rotation between these parts.

The construction illustrated in Fig. 8 is identical to that illustrated in Figs. 6 and 7 and similar parts are indicated by the same numerals, the main difference in this case being that the tapered end 120' of the shaft 100' is provided with a plurality of splines 128 thereon and the bore 106' is provided with a corresponding number of opposed grooves or keyways which receive the splines 128 therein to prevent relative rotation between the throw and the shaft portion 100'. The peripheral surfaces of the splines lie in the surface of a cylinder and the keyways in the throw 102' are correspondingly formed, this for the purpose of ease in manufacture.

In the modification illustrated in Fig. 9 the same shaft 100 is employed as in Figs. 1 and 2 and the throw 102'' is provided with a counterweight portion 103'' the same as in the construction illustrated in Figs. 1 and 2 and is provided with a cylindrical bore for reception of the outer end of the shaft 100. The counterbalance portion 103'' is in this case also split but instead of being split centrally is split adjacent one edge of the counterweight illustrated at 104 and a screw 130 is extended through the split portion of the counterbalance 103'' to contract the corresponding portion of the throw 102'' about the outer end of the shaft 100.

In the construction illustrated in Fig. 10 the same shaft 100 is employed as in Figs. 1 and 2 and in Fig. 9. The throw 102a is provided with a counterbalance portion 103a and is provided with a bore 106a for reception of the outer end of the shaft 100 the same as in the construction illustrated in Figs. 1 and 2. The counterbalance portion 103a is not split in this modification but a pin 112a corresponding to the screw 112 previously described passes transversely through the counterbalance portion 103a in intersecting relation with respect to the surface of the shaft 100. The pin 112a in this case, however, is of tapered conformation and the small end thereof which projects beyond the corresponding faces of the counterbalance portion 103a is formed to provide a stud 140 thereon which receives a nut 142 and serves to draw the same tightly into engagement with the outer end of the shaft 100.

It will be appreciated that any of the constructions illustrated in Figs. 6 to 10, inclusive, are applicable for use in place of the construction illustrated in Figs. 1 and 2.

Formal changes may be made in the specific embodiments of the invention described without departing from the spirit or substance of the broad invention, the scope of which is commensurate with the appended claims.

What I claim is:

1. In combination, a cylinder head, a crankcase portion formed integrally with said cylinder, a bore in said cylinder for reception of a piston, a bore in said crankcase for reception of a crank shaft and arranged with its axis perpendicular with respect to the axis of said cylinder, a face on said crankcase portion extending at an angle to the axes of both the cylinder and said bore for said crank shaft and having an opening therein through which tools may be inserted to machine both the bore of said cylinder and said bore for said crank shaft, and a closure for said opening.

2. In combination, a cylinder having a bore and a piston reciprocable therein, a crankcase portion integral with said cylinder and having a bore therein arranged at right angles to the axis of said cylinder, a crank shaft rotatably mounted in the last mentioned bore, means operatively connecting said crank shaft and said piston, a face on said crankcase portion disposed at an angle to both of said bores, said face having an opening therein through which the entire circumference of both of said bores are viewable axially of said bores, and means sealed to said face forming a closure for said opening.

3. In combination, a cylinder having a bore adapted to receive a piston, a crankcase portion formed integrally with said cylinder and having a bore adapted to receive a crank shaft with its axis at right angles to the bore of said cylinder, and a face on said crankcase portion arranged with the plane thereof at an angle to both of said bores, said face having an opening therein through which tools may be introduced into both of said bores axially thereof for the purpose of machining the same.

4. In combination, a cylinder having a bore, a crankcase portion formed integrally with said cylinder and provided with a bore for reception of the crank shaft, said bores being arranged at right angles to one another, a planar face on said crankcase portion arranged with the plane thereof disposed at an angle of approximately 45° to the axis of both of said bores, said face having

an opening therein providing access to both of said bores.

5. In an internal combustion engine or the like, in combination, a cylinder, a piston reciprocable in said cylinder, a crankcase portion formed integrally with said cylinder and having a bore disposed at right angles to the bore of said cylinder, a crank shaft rotatably mounted in said bore in said crankcase portion, means operatively connecting said crank shaft and piston, a planar face on said crankcase portion disposed at an angle to both the axes of said cylinder and said crank shaft, said face having an opening therein through which said piston is removable and permitting an unobstructed view of the entire circumferential extent of the bore in said crankcase portion axially thereof, and a pan closing said opening.

6. In an internal combustion engine or the like, in combination, a cylinder, a piston reciprocable in said cylinder, a crankcase portion formed integrally with said cylinder and having a bore therein disposed at right angles to the bore of said cylinder, a crank shaft rotatably mounted in said bore in said crankcase portion, means operatively connecting said crank shaft and piston, said crankcase portion having a planar face thereon disposed at an angle to the axis of both said cylinder and said crank shaft, an opening in said face permitting the introduction of tools into both of said bores axially thereof for the purpose of machining the same, and a closure for said opening forming an additional bearing for said crank shaft.

7. In an internal combustion engine or the like, in combination, a pair of cylinders arranged in opposed relationship, a crankcase portion integral with each of said cylinders, said crankcase portions having a line of split between them arranged in a plane disposed at an angle to the axes of both said cylinders, means securing said crankcase portions together, a bearing carried by each of said crankcase portions, and a crank shaft rotatably supported between said bearings.

8. A two cylinder opposed internal combustion engine or the like comprising, in combination, a pair of identical cylinder and crankcase units arranged in opposed relationship and secured together, each of said units including a cylinder and a crankcase portion formed integrally therewith, a crank shaft bearing carried by each of said crankcase portions with the axis thereof arranged perpendicularly with respect to the axis of the corresponding cylinder, an angularly disposed face on the crankcase portion of each of said units and said angularly disposed faces being secured together in opposed and complemental relationship with the axes of said cylinders aligned with one another, a crank shaft rotatably mounted between the bearings of said units, a piston in each of said cylinders, and means operatively connecting said pistons to said crank shaft.

9. In an internal combustion engine or the like, in combination, a cylinder, a piston reciprocable in said cylinder, a crankcase portion formed integrally with said cylinder and having a bore therein disposed at right angles to the axis of said cylinder, a crank shaft rotatably mounted in said bore, means operatively connecting said crank shaft and said piston, said crank shaft including a cylindrical shaft portion and a separately formed throw and crank pin portion removably received thereon, means locking said throw to said cylindrical portion, and a planar face on said crankcase portion disposed at an angle to both the axes of said cylinder and said crank shaft, and said face having an opening therein through which both said throw and piston are removable.

10. In an internal combustion engine or the like, in combination, a cylinder, a piston reciprocable in said cylinder, a crankcase portion formed integrally with said cylinder and having a bore therein disposed at right angles to the axis of said cylinder, a crank shaft rotatably mounted in said bore, means operatively connecting said crank shaft and said piston, said crank shaft including a cylindrical shaft portion and a separately formed throw and crank pin portion removably received thereon, means comprising a member carried by said throw in intersecting relation with respect to the surface of said cylindrical portion locking said throw to said cylindrical portion, and a planar face on said crankcase portion disposed at an angle to both the axes of said cylinder and said crank shaft, and said face having an opening therein through which both said throw and piston are removable.

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ENGINE

Filed Dec. 4, 1939 5 Sheets-Sheet 1

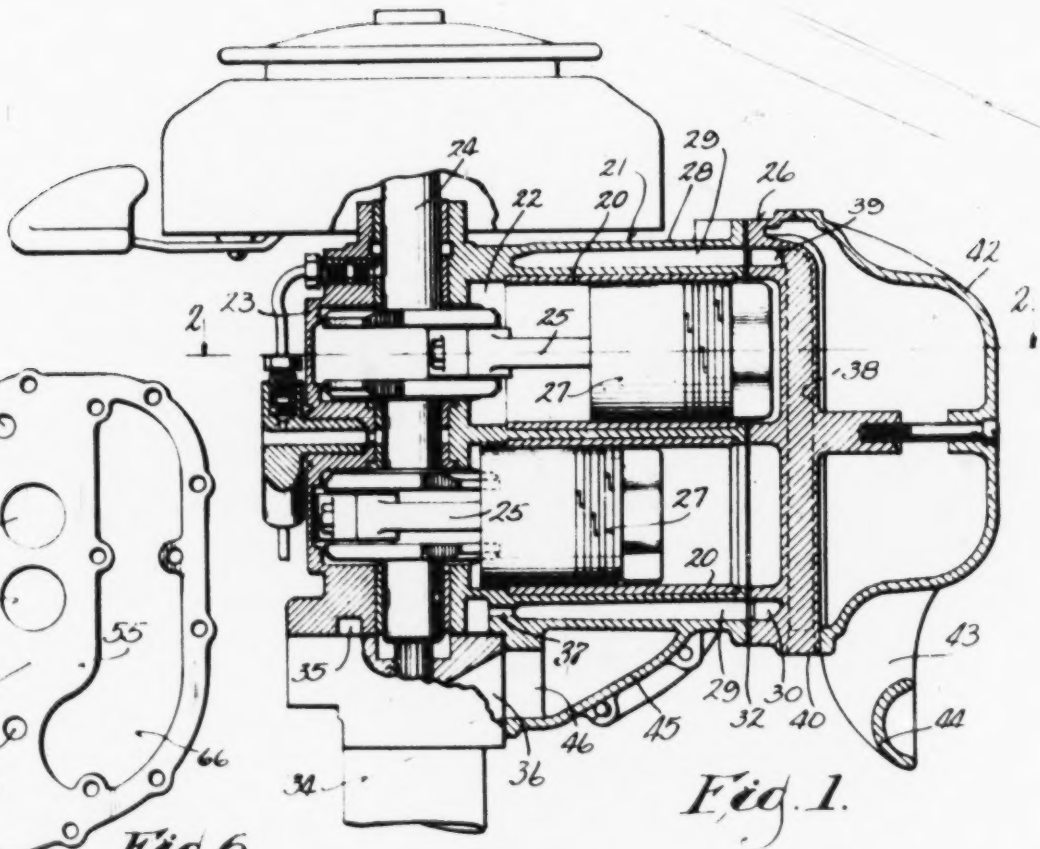

Fig. 1.

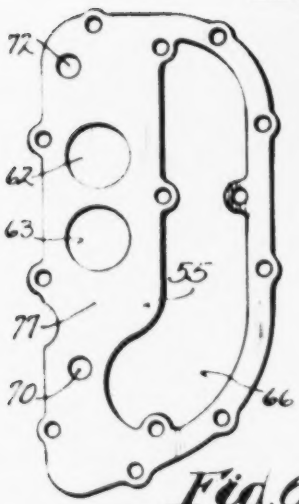

Fig. 6.

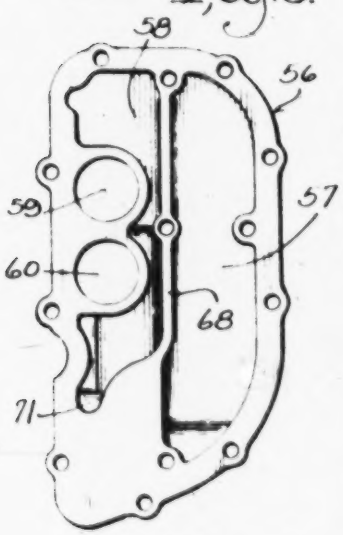

Fig. 5.

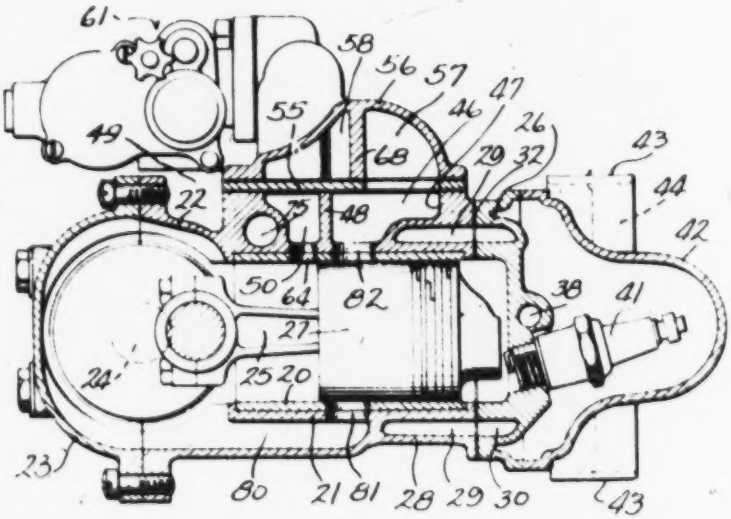

Fig. 2.

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ENGINE

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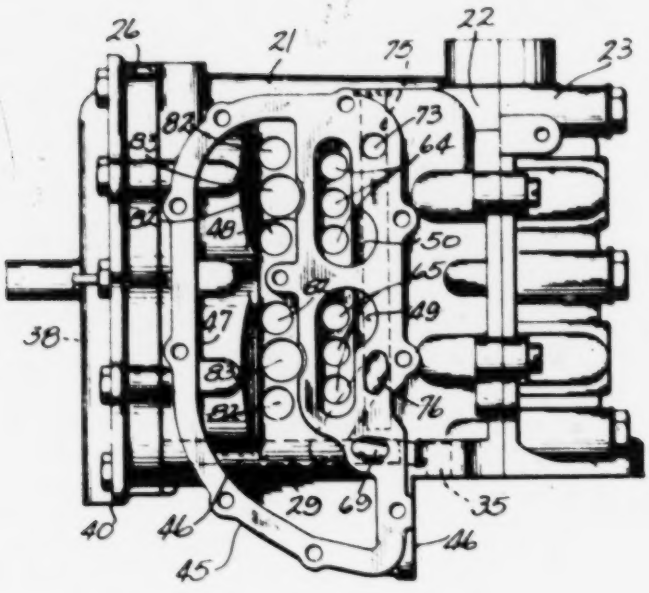

Fig. 3.

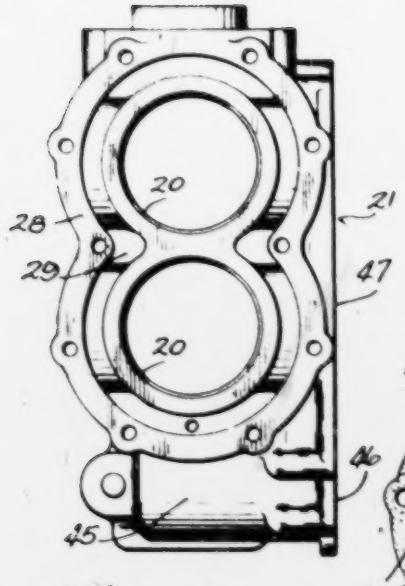

Fig. 4

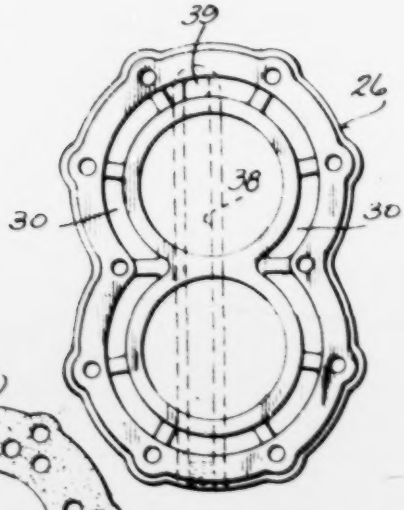

Fig. 7.

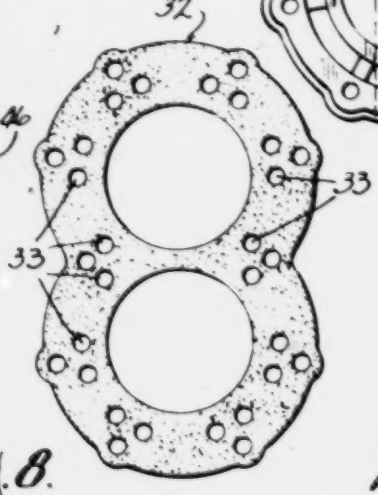

Fig. 8.

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ENGINE

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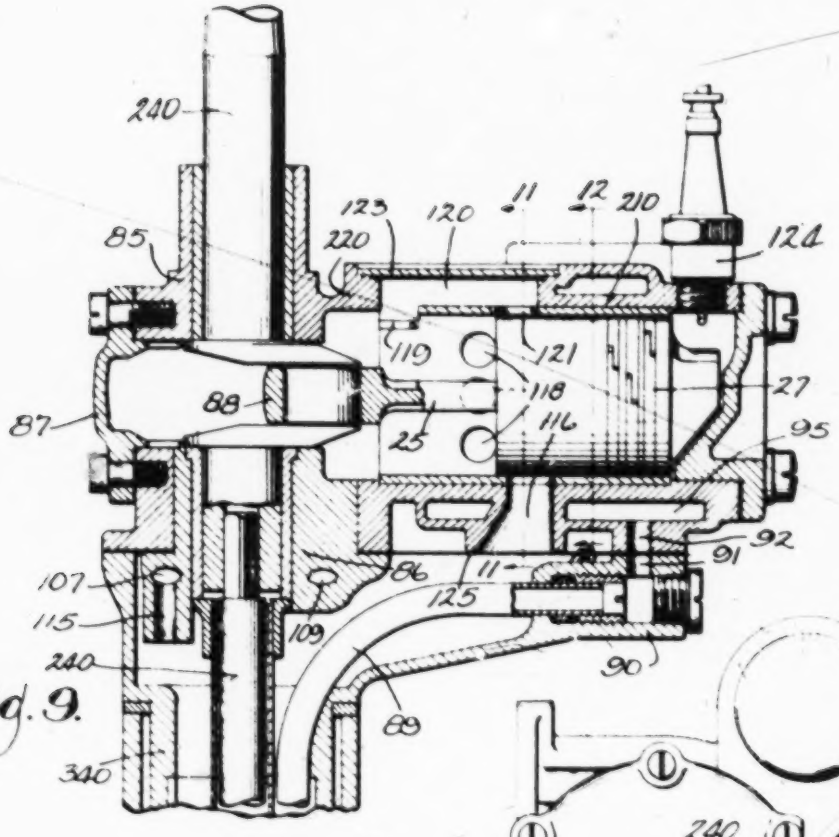

Fig. 9.

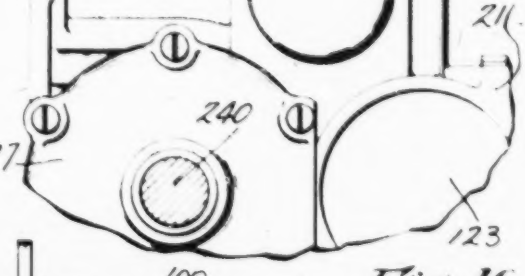

Fig. 16.

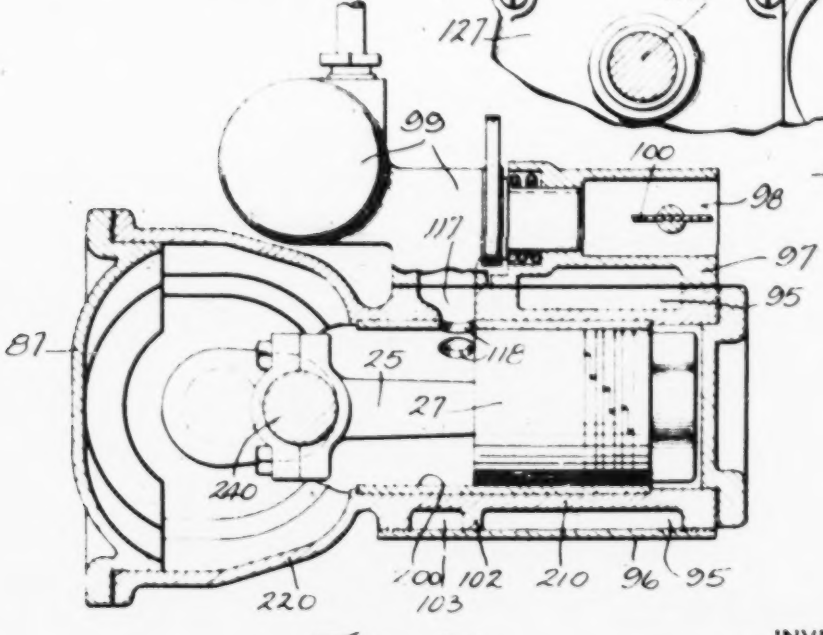

Fig. 10.

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ENGINE

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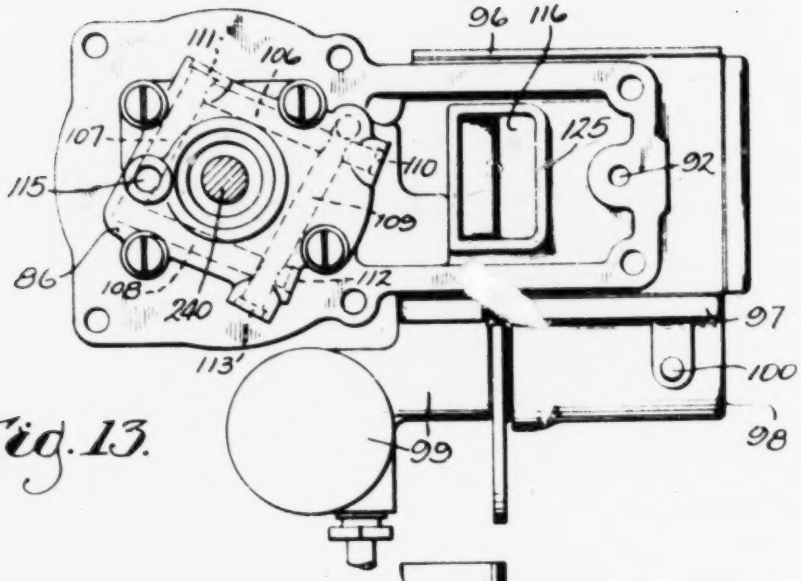

Fig. 13.

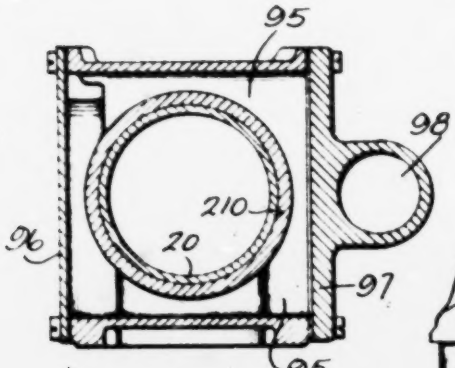

Fig. 12.

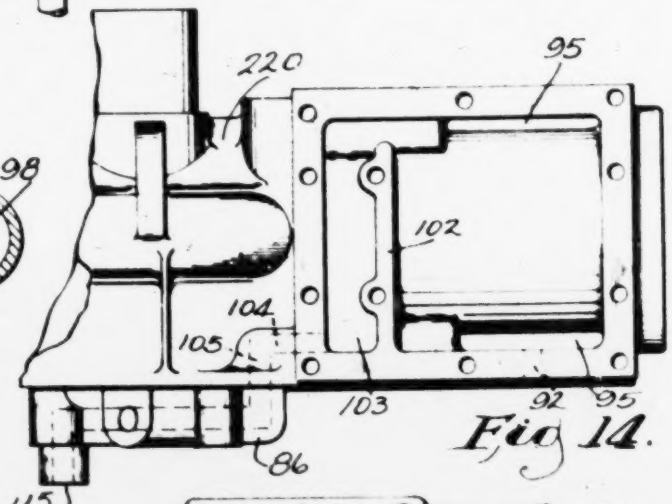

Fig. 14.

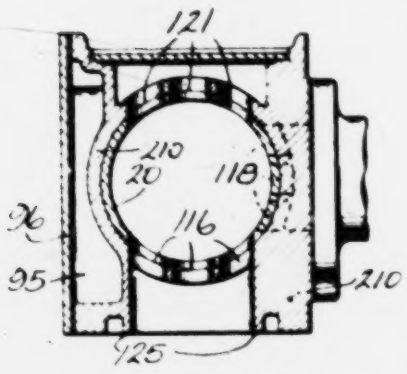

Fig. 11.

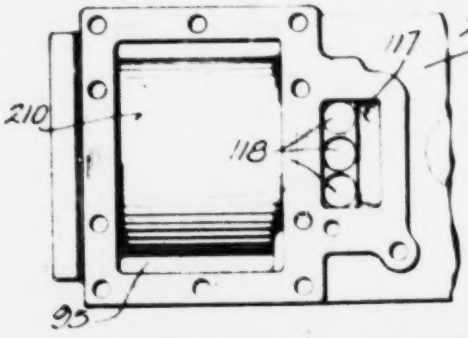

Fig. 15.

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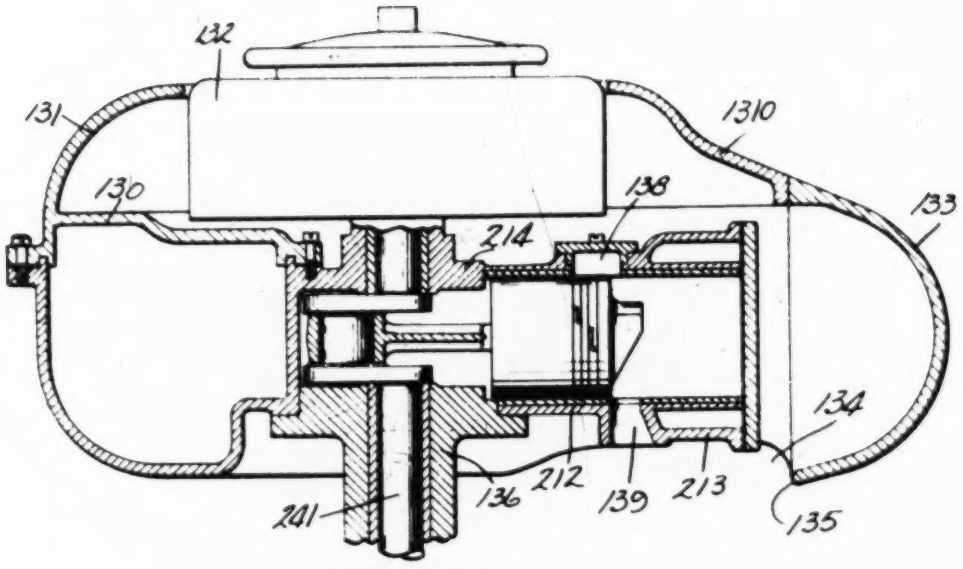

Fig. 17.

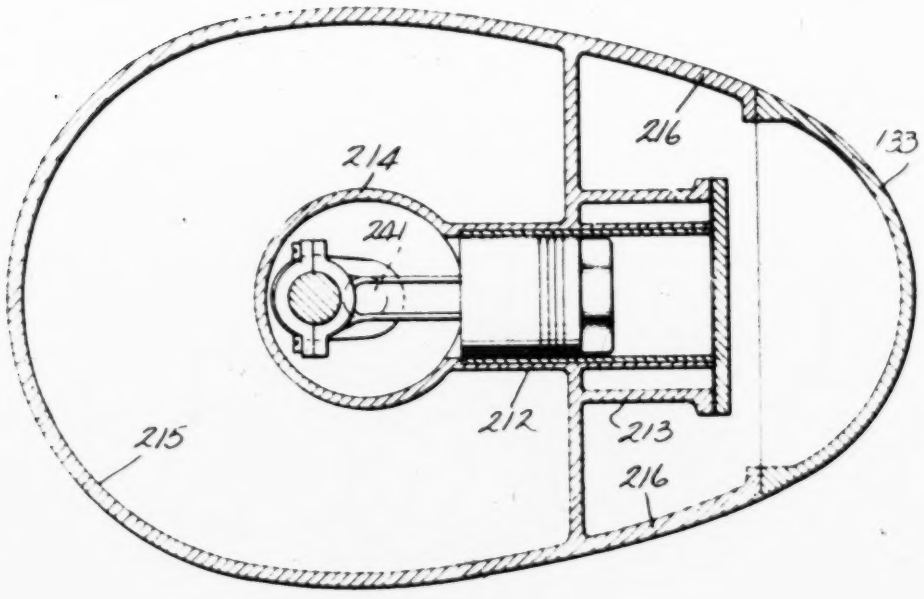

Fig. 18.

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Patented Dec. 31, 1940 2,227,247

UNITED STATES PATENT OFFICE

2,227,247

ENGINE

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Application December 4, 1939, Serial No. 307,443

22 Claims. (Cl. 123—173)

This invention relates to improvements in engines.

Generically, it is the primary object of the present invention to provide novel and improved engine constructions with particular reference to the location and formation of cores, passages and jackets to facilitate the die casting of the engine cylinder and crank case structure. In this connection, it is a major purpose to provide for the die casting of most of the cylinder blocks and crank cases in single operations, whereby in each engine so cast the cylinder block and half or more than half of the crank case are preferably made in one piece, not only to reduce assembly costs but to assure perfect alignment.

More specifically, the present invention includes among its various objects the provision of means whereby a core for the transfer passage may be withdrawn through clearance provided in the crank case; to provide novel and improved arrangement and disposition of drilled holes constituting transfer and fuel admission ports; to provide novel and improved arrangements of water jackets to facilitate coring in the construction of a die cast engine; to provide a die cast engine wherein the die cast material is compacted under pressure upon a cylinder sleeve incorporated as being inserted in the die cast; to provide novel and improved arrangements for carburetion including an integral unitary organization of fuel tank, crank case, and engine cylinder block in which the principal portions of these various devices are die cast in a single piece; the provision of a novel organization of mixture, inlet and exhaust passages whereby such passages are formed partially in a cylinder block casting and partially in a separate casting and partially by an intervening plate partition; the provision of novel water passage openings to facilitate die cast construction and circulation throughout the surfaces to be cooled; together with numerous other objects which will be apparent to those skilled in the art upon study of the following disclosure of the invention.

In the drawings:

Fig. 1 is a vertical axial section through a two cylinder engine organized for alternate firing and embodying the present invention.

Fig. 2 is a view in horizontal section through the engine on the center line 2—2 of Fig. 1 of the upper cylinder.

Fig. 3 is a side elevation of the engine as it appears with the inlet and exhaust ports exposed by the removal of a die casting providing inlet and exhaust passages.

Fig. 4 is an end elevation of the engine as it appears with the cylinder head removed.

Fig. 5 is a view of the inlet and exhaust casting showing the inner face applicable to the facing illustrated in Fig. 3.

Fig. 6 is a side elevation of the plate which intervenes between the casting as shown in Fig. 3 and Fig. 5.

Fig. 7 is a view in elevation of the interior face of the cylinder head as it appears when removed from the cylinder block shown in Fig. 4.

Fig. 8 is a view in elevation of the gasket which intervenes between the die casting as shown in Figs. 4 and 7.

Fig. 9 is a view in vertical axial section through a single cylinder engine embodying the invention.

Fig. 10 is a view of the same engine as it appears in a section taken horizontally in the plane of the cylinder axis.

Fig. 11 is a view taken in section in the plane indicated at 11—11 in Fig. 9.

Fig. 12 is a view taken in section in the plane indicated by the line 12—12 in Fig. 9.

Fig. 13 is a bottom plan view of the engine shown in Fig. 9 as it appears when removed from its support on the shaft housing.

Fig. 14 is a view of the cylinder block casting of the same engine in side elevation with one of its side cover plates removed to expose the jacket.

Fig. 15 is a view in side elevation of the opposite side of the cylinder block casting of the same engine with its side cover plate removed to expose the jacket.

Fig. 16 is a plan view showing a fragment of an engine structure slightly modified from the disclosure of Fig. 10.

Fig. 17 is a view in vertical axial section through a further modified single cylinder engine embodying the invention.

Fig. 18 is a view in horizontal section in the plane of the cylinder axis of the engine shown in Fig. 17.

Like parts are identified by the same reference characters throughout the several views.

The engine shown in Figs. 1 to 8, inclusive, on the first two sheets of drawings will first be described. A sleeve 20 of iron or other suitable material is cast as an insert into a single die casting unitarily providing the dual cylinder block 21 and that half portion 22 of the crank case which is contiguous to the cylinders. The other half 23 of the crank case is removably bolted to crank case portion 22 to afford access to the crank shaft 24 and connecting rods 25.

The cylinder head 26 comprises a separate die casting unitarily closing the ends of both of the cylinders to receive the compression of the pistons 27 reciprocable therein. As clearly shown in Figs. 1, 2 and 4, the single die casting which provides the cylinders is made to provide also a jacket wall 28 within which there is a jacket space or water passage 29 which, as indicated in Fig. 1 and Fig. 4, is relatively deep along the top and bottom surfaces of the cylinders and, as shown in Figs. 2 and 4, is relatively shallow, as measured from the cylinder head, at the opposite sides of the cylinders where the various ports are provided as hereinafter to be described.

The die casting 26 which provides the cylinder head is likewise formed with a jacket to provide a jacket space or water passage 30 as indicated in Figs. 1, 2 and 7. In order that the cylinder head may reach a higher temperature than the cylinders, communication between the water passages 29 of casting 21 and the water passages 30 of casting 26 is preferably materially restricted by the intervening gasket 32 which, as shown in Fig. 8, has relatively small openings 33 which may conveniently be arranged in pairs at spaced intervals to permit water to flow from the cylinder jacket space to the jacket space of the head.

Assuming that the engine is used on an outboard motor and is mounted on the shaft housing 34 of such a motor, the water supply may be led upwardly through the shaft housing and delivered to the channel 35 which surrounds the lower crank shaft bearing, being formed partly in the crank case casting 23 and partly in the casting portion 22 of the cylinder block. As explained in companion application No. 212,078, the admission of cooling water about this bearing serves to protect the bearing from the direct heat of the exhaust which is led below the water line through passage 36 formed in the upper end of the shaft housing in a manner hereinafter to be explained. From channel 35, the cooling water passes through a cooling passage in a cover casting which provides an expansion chamber and intake manifold as hereinafter described. From this passage, the water returns to the lower part of the jacket space 29 in a manner which will also be described hereinafter. There may, however, be some small amount of flow through a very restricted opening 37 (Fig. 1) which affords direct communication between channel 35 and jacket 29 primarily for the purpose of drainage.

The water admitted to the jacket must completely fill the jacket space 29 about both cylinders and the jacket space 30 about the heads of the cylinders before it can escape. The only outlet for the cooling water is through the vertical duct 38 cast into the cylinder head casting 26 and opening from the jacket space 30 at 39 (Fig. 1) downwardly across the ends of the cylinder heads. This duct opens outwardly at 40 and the water may either be discharged at that point or led by a suitable pipe to any desired place of discharge. In actual practice, there is a pipe (not shown) which returns the water to the exhaust passage to cool the exhaust gases.

The spark plugs 41 are offset laterally from the duct 38 as shown in Fig. 2. They are preferably completely enclosed by a shell 42 which fits tightly to the cylinder head die casting 26 to exclude moisture from the spark plugs. As shown in Fig. 1, this same shell is preferably provided unitarily with arms 43 projecting downwardly and connected by a transverse handle 44 to facilitate the manipulation not only of the engine, but of the outboard motor structure as a whole.

The die cast block in which the engine cylinders are formed is provided with a hollow downward extension at 45 opening at 46 in the direction of the crank shaft 24 to afford communication with the exhaust passage 36 of the shaft housing 34 of the outboard motor. The interior of the hollow extension 45 communicates with a manifold passage 46 which takes the form of a cavity exposed at the side of die casting 21 and formed by the laterally projecting walls 47 and 48. The wall 49 is a partition between the manifold cavity 46 and the separate cavities 49 and 50 through which the combustible mixture is supplied to the engine. Obviously, the cavities 46, 49 and 50 can conveniently be provided for by a laterally retractible core means.

The laterally upstanding walls about the cavities 46, 49 and 50 are finished to a common plane to receive a partition plate 55 (Figs. 2 and 6) and a die casting 56 which unitarily provides an expansion chamber 57, a jacket space 58 and a pair of passages 59 and 60 through which the carburetor 61 supplies combustible mixture to the cavities 49 and 50 of the die casting 21. Die casting 56 is best illustrated in Figs. 2 and 5. The plate 55 has an opening 62 registering with passage 59 and cavity 50 and a similar opening 63 registering with passage 60 and cavity 49 to afford communication for the flow of combustible mixture to the admission ports 64 of the upper cylinder and the admission ports 65 of the lower cylinder, respectively.

A large opening 66 in the plate 55 affords virtually unrestricted communication between the exhaust passage cavity 46 of the cylinder die casting 21 and the expansion chamber cavity 57 of the separate die casting 56. However, because the partition 68 between the expansion chamber 57 and the jacket space 58 in the auxiliary die casting 56 is offset from the partition 48 between the exhaust cavity 46 and the inlet space 50 of cylinder casting 21, that portion of plate 55 which extends between partitions 48 and 68, as shown in Fig. 2, is imperforate.

The jacket space 58 of die casting 56 is supplied with cooling water by a system which is in series with a portion of the main cooling system already described.

From the channel 35 about the lower crank shaft bearing in castings 21 and 23, a hole 69 (Fig. 3) is drilled in such a way as to open at the surface of the wall 47 to communicate with a hole 70 (Fig. 6) in the plate 55 which leads to the portion 71 of the lower end of the jacket space 58 in the cover casting 56. Thus, the water in jacket space 58 cools the hot gases in chamber 57. As the water level rises to the top of jacket space 58, it is permitted to pass from said space through the hole 72 in plate 55 (Fig. 6) and to enter the registering hole 73 in the cylinder casting 21 (Fig. 3), passing thence downwardly through the hole 75 (Figs. 2 and 3) to an inclined hole 76 (Fig. 3) which returns the water back to the main jacket space 29. In order to drill the inclined hole 76, it is necessary to enter the casting through the exposed face shown in Fig. 3, but this is covered by the imperforate area 77 of plate 55 (Fig. 6) so that the hole 76 affords communication only between the vertical hole 75 and the main jacket 29 to which the water is returned.

The mixture supplied by carburetor 81 and entering the cylinders through ports 84 and 85 in the manner described, reaches the cylinders below the pistons therein and is compressed in the respective crank cases for delivery through the transfer passages 80 at the sides of the cylinders, one of which is shown in Fig. 2. It will be noted that this transfer passage has an unobstructed side wall opening parallel to the axis of the cylinder so that in the die casting of the part 21 the core, which makes the transfer passage, can be withdrawn endwise from the casting. At its outer end, the transfer passage 80 communicates with the transfer port 81 which is bored through the cylinder sleeve 20 and through the adjacent portions of casting 21. This boring is done from the opposite side of the cylinder at an appropriate angle from the exhaust manifold passage 46 to provide the exhaust ports 82 and 83. In each cylinder, three such ports are provided, as shown in Fig. 3, the central port being of larger diameter than the two side ports because it enters the cylinder on a major diameter of the cylinder and, therefore, has less cross sectional area in proportion to the diameter of the hole than do the ports 82 which enter the cylinder on minor chords thereof. The fact that the several ports are bored somewhat obliquely with reference to the axis of the cylinder locates the exhaust ports slightly nearer the cylinder heads than are the transfer ports 81, thus enabling the exhaust ports to open earlier and close later than the transfer ports in accordance with approved practice.

The construction shown in Figs. 9 to 15 on sheets 3 and 4 of the drawings will now be described. While the device illustrated is a single cylinder engine, the manner in which the passages open to facilitate coring may be adapted to engines of the type shown in Figs. 1 and 2. Similarly, the arrangement of the water passages shown in Figs. 1 and 2 is also adaptable to the single cylinder construction now to be described.

As in the previously described construction, it is preferred to die cast in one piece under pressure about a cylinder sleeve 20 a single casting unitarily providing a cylinder portion 210 and a crank case portion 220. In this instance, the crank case portion 220 includes the whole of the upper crank shaft bearing 85. The lower crank shaft bearing 86 is provided by a separate part and a removable enclosure plate 87 affords access to the bearing cap 88 of the connecting rod 25, which is operated by piston 27 in the conventional way. In this device, the water supply carried up the shaft housing 340 in a tube 89 is delivered into the casting 90 which serves as a motor support at the upper end of the shaft housing and thence passes through a hole 91 in casting 90 and a registering hole 92 in casting 210 into the jacket space 95 which completely surrounds the cylinder but, instead of opening to the end of casting 210, opens toward both sides thereof as is clearly shown in Figs. 10, 12, 14 and 15. At each side of casting 210, finished planiform surfaces are provided to receive cover plates for completing the enclosure of the water jacket space. The cover plate 96 (Figs. 10, 11 and 12) performs no function other than to close the jacket space. The closure 97, however, at the other side of casting 210, can conveniently be made to provide the air inlet passage 98 to the carburetor 99 and to serve as a mounting for the choke valve 100 (Fig. 10).

The water admitted through the hole 92 into the jacket space 95 rises to a level substantially filling the jacket space before it overflows the partition 102 which constitutes a dam extending between the closure 96 and the main cylinder block casting 210 and preferably constituting a part of the cylinder block casting as shown in Fig. 14. Having overflowed the top of partition 102, the water passes downwardly along the inner end of the cylinder to the bottom of the well 103 where a pair of holes 104 and 105 communicating at right angles lead the water into the bearing casting 86.

This casting, which provides the lower bearing for crank shaft 340, is provided with water passages communicating at the corners of a substantially square figure surrounding the bearing to keep the bearing cool. These passages 106, 107, 108 and 109, which are either drilled or cored, communicate with the exterior of the casting, being cut off by plugging the passages at 110, 111, 112 and 113, respectively. The hole 105 is intersected by the end of passage 109 closely adjacent to the point of intersection between passages 106 and 109 at one corner of the square. The water passes in both directions around the square through passages 106 and 109 to passages 107 and 108 and the discharge is effected through an outlet hole 115 opening from passage 107 (Figs. 9 and 13). Thus, the lower crank shaft bearing is cooled by the water leaving, rather than entering, the engine. The discharge water flows directly into the upper end of the shaft housing 340 where it mingles with the exhaust gas delivered into the shaft housing through the engine carrying fixture 90 from the exhaust port 116.

The combustible mixture supplied by the carburetor 99 enters the cylinder below piston 27 through the passage 117 with which the carburetor registers, such passage leading to a series of inlet ports 118 (Figs. 10 and 15). After being compressed in the crank case, the charge is transferred through port 119 in the wall of cylinder sleeve 200 into a transfer passage 120 which is round in side elevation and is formed by coring out the side of the main casting 210. The port 119 opens into the side of this cavity which is closest to the inner end of the cylinder. From the side of cavity 120 which is nearest the outer end of the cylinder, a series of ports 121 (Figs. 9 to 11) open through the sleeve 200 to the interior of the cylinder to be uncovered by the piston at the end of its expansion stroke. Ports 121 are opposite the exhaust ports 116 and may conveniently be made in a single operation by drilling from the open cavity 120 completely across the cylinder to intersect both sides thereof. By drilling these holes at a slight angle, the exhaust ports 116 may be located nearer the cylinder head than the transfer ports 121, thus causing the exhaust ports to be first uncovered by the piston during the expansion stroke and last covered on the compression stroke. The cavity 120 which serves as a transfer port and also affords access for the drilling of ports 119, 121 and 116 is closed by a disk-like plug 123 pressed into place against a suitable shoulder.

This engine illustrates one way in which the spark plug 124 may be located at the side rather than the end of the cylinder head.

Because this engine is illustrated in an outboard motor structure and it is desired to prevent the return flow into the cylinder of the cooling water which is discharged into the path of the exhaust in the upper end of shaft housing 340, the principal casting 210 comprising the cylinder block and crank case is provided about

the exhaust support 116 with an annular flange 126 (Figs. 9 and 11) which serves as a dam. As illustrated, this dam has sufficient height so that, regardless of the position of the motor, and even if it should be completely inverted, any water normally present in the shaft housing and tending, by reason of the inversion of the motor, to follow the exhaust gas passages, would be prevented from entering the channel 116 leading to the cylinder.

The construction shown in Fig. 16 is, in general, similar to that disclosed in Figs. 9 to 15, inclusive, except that the carburetor casing 126 is, in this structure, cast integrally with the cylinder block casting 211. This drawing further illustrates the possibility that the top bearing for the crank shaft 240 may be provided by a separable crank case member 127.

Figs. 17 and 18 do not go into detail with regard to water passages or passages for the admission or transfer of the combustible charge. The purpose in Figs. 17 and 18 is to disclose an arrangement in which a single casting, preferably made by die casting, includes the engine cylinder 212, its jacket 213, the top and side walls of the crank case 214, the fuel tank 215 and flanges 216, which provide fairing along the sides of the cylinder. Upon the fuel tank 215 is mounted another die casting which unitarily comprises a cover 130 for the fuel tank and the front shroud 131 for the fly wheel 132. Applied to the fairing 216 at the rear of the cylinder is a spark plug cover shell 133, the interior of which communicates with the shroud to receive the blast of air centrifugally established by the rotation of the fly wheel, such blast being discharged across the end of the cylinder through an opening at 134 in shell 133. The margin of this opening is rounded at 135 to serve as a carrying handle.

An intermediate shroud section 1310 extends from the front shroud 131 to the cover shell 133 and may be cast integral with fairing flanges 216.

The crank shaft 241 upon which fly wheel 132 is mounted, has its lower bearing in a removable closure 136 fitted to the lower end of the crank case. The bearing sleeve will ordinarily be extended to comprise a housing for the extension of the crank shaft 241 in an outboard motor structure, but it may be otherwise designed for other uses. It will be apparent that the fuel itself surrounds the sides of the entire end of the cylinder and the construction provides an extremely inexpensive and simplified way of constructing a light motor with comparatively few parts requiring assembly. As viewed in Fig. 17, the core used in forming the crank case is withdrawn downwardly, the core used in forming the fuel tank is withdrawn upwardly and the core used in forming the cylinder and its jacket space may be withdrawn endwise of the cylinder. The core used to form the transfer passage 138 and that used to form the exhaust passage 139 are withdrawn upwardly and downwardly, respectively.

In each of the several constructions illustrated, the main or principal casting comprises the engine cylinder block and at least a portion of the crank case and is die cast under pressure upon the sleeve-like insert which constitutes the cylinder lining. In the construction first described, the crank case is supported upon a transverse plane including the axis of the crank shaft and the core means forming that portion of the crank case included in the aforesaid casting, is withdrawn axially of the cylinder, along with the core means which form the transfer port. The core means forming the support for the cylinder sleeve and the core means forming the jacket portion of the main casting are withdrawn in the opposite direction upon the same axis. The other core means withdrawn laterally provide passages for gas and give access to the portions of the principal casting in which the ports are to be drilled through the casting and the liner sleeve.

In the constructions shown on Sheets 2 to 5 of the drawings, the ports are also arranged for the withdrawal in directions lateral with respect to the cylinder axis of the core means which form the respective passages for gas and which give access to the points where the ports are drilled into the principal casting.

In each of the constructions shown in Figs. 1 to 4, the closures applied over the cavities formed in the aforesaid corresponding operations perform additional functions in the support of ancillary equipment, such as the carburetor, or in the provision of supplemental passages and chambers.

In each of the structures shown on Sheet 1 and Sheet 5, the spark plug cover is made not only to protect the spark plug but to provide a lifting handle for convenient manipulation of the engine and the outboard motor of which it may be part.

With particular reference to the construction shown in Figs. 1 to 8, inclusive, cylinder distortion is substantially eliminated by locating the holding screws for the cylinder head on the water jacket rather than the cylinder proper. In the construction shown in Fig. 9, the cylinder is extended sufficiently beyond the piston travel to receive the screws at a point where there is no piston bearing. In this construction, also, therefore, the portion of the cylinder traversed by the piston is free of distortion.

I claim:

1. In an engine having a crank case, cylinder and jacket, the combination in a single casting of a crank case portion having a hollow interior with walls progressively and unobstructedly opening outwardly, a cylinder portion having a hollow cylindrical interior with walls unobstructedly opening outwardly, and a jacket spaced from said cylinder portion to provide a hollow cavity for coolant with walls progressively and unobstructedly opening outwardly, whereby each of said cavities is adapted to be formed by a die in a die casting operation.

2. In an engine having a crank shaft, crank case, cylinder, and jacket, the crank case comprising two complementary parts to provide an internal cavity and joined substantially in the transverse plane of the crank case, the combination in a single casting of the crank case part adjacent the cylinder, a cylinder block in which the cylinder is provided with a jacket space, said jacket space opening to the end of the cylinder opposite from the crank case with unobstructed wall surfaces adapted to permit of the withdrawal of a die following the formation of said casting in a die casting operation, the crank case portion included in said casting having an extension along the side of said cylinder constituting a transfer passage with unobstructed wall surfaces opening into the cavity of said crank case portion, whereby to be adapted for formation with said crank case cavity by die means withdrawable in a direction generally axial with re-

spect to said cylinder, together with closures for the several cavities in said casting comprising a complementary crank case section for closing the space between the cylinder and the jacket.

3. An engine comprising a block provided with a horizontal cylinder and a jacket cavity about the cylinder, a cylinder head including a closure for said jacket cavity and cylinder, said head having a water passage opening downwardly across said head and communicating with said jacket cavity solely at the top thereof, and means for introducing water into said jacket cavity at the bottom thereof, whereby said cavity is required to fill before water will discharge through said head.

4. The combination with a cylinder block having a cylinder and a jacket space opening to the end of the cylinder block, of a head having a complementary jacket space opening toward the end of the cylinder, said head constituting a closure for the cylinder and a closure for the jacket space, and an intervening gasket plate apertured to provide for restricted communication between the otherwise fully communicating jacket space of the cylinder and the jacket space of the head.

5. The combination with a cylinder block having a cylinder and a jacket space opening to the end of the cylinder block, of a head having a complementary jacket space opening toward the end of the cylinder, said head constituting a closure for the cylinder and a closure for the jacket space, and an intervening gasket plate apertured to provide for restricted communication between the otherwise fully communicating jacket space of the cylinder and the jacket space of the head, said head having no jacketing across the end of the cylinder except a single discharge passage leading from said jacket space and extending substantially diametrically across said head.

6. In a device of the character described, the combination with a cylinder block and head, of a spark plug in the head, a cover for the spark plug secured thereabout, and a handle mounted on the cover for manipulation of said cylinder block.

7. In a device of the character described, the combination with an engine having a cylinder provided with a head, of a spark plug in the head and a spark plug cover comprising a shell closely fitted to said head about said spark plug and formed to provide a carrying handle to facilitate the manipulation of said engine.

8. In a device of the character described, the combination with a casting providing at least one cylinder and a crank case section in integral connection with the end of the cylinder, of a transfer passage having a wall integrally formed in the angle between the crank case portion and cylinder, said passage opening into the crank case portion and extending rectilinearly along the cylinder wall, means at the other side of the cylinder wall from said transfer passage comprising extensions of said wall to constitute intake and exhaust cavities, said cylinder having holes drilled from the respective cavities into the cylinder, certain of said holes being extended across said cylinder into said transfer passage to afford communication between said passage and cylinder, and closure means for said cavities.

9. In an engine, the combination of a cylinder block and a cooling jacket space opening to the same end of the block as the cylinder, the other end of said block being expanded to provide integrally a half section of a crank case, one side of the block being integrally formed to provide a transfer passage opening uninterruptedly into said crank case section and extending along the side of the block, the other side of the block having laterally opening adjacent cavities of substantial depth comprising mixture admission and exhaust cavities respectively, said block having holes affording communication between the transfer passage and the cylinder and between the mixture admission cavity and the cylinder and between the cylinder and the exhaust cavity, said holes between the transfer passage and the cylinder and between the exhaust cavity and the cylinder being axially aligned to permit their formation in a single drilling operation, and closures for the ends and side of said block comprising a crank case section at one end of the block, a cylinder head at the other end of the block including a closure for said jacket space, and a closure for the said cavities, said last mentioned closure being provided both with carburetion means and with an expansion chamber, the latter chamber communicating with the exhaust cavity.

10. In an engine having a vertical crank shaft and horizontally reciprocable pistons in operative connection with the crank shaft, the combination with two crank case parts joined in a transverse plane at the crank shaft to provide upper, lower and intermediate bearings therefor and separate crank cases between the bearings, cylinders in which said pistons are reciprocable, said cylinders being formed in a single cylinder block casting of which the crank case section contiguous thereto is a part, a jacket likewise comprising a part of said casting and spaced from said cylinders to provide a jacket space for coolant about the cylinders, said jacket space and cylinders opening to the end of the casting opposite the crank case, means likewise forming an integral part of said casting providing separate transfer passages opening with unobstructed wall surfaces from the respective crank cases of said crank case section and extending thence along the sides of the respective cylinders, said cylinders being provided with ports opening from said passages into the cylinders, means at the sides of said cylinders opposite said transfer passage means comprising spaced laterally projecting walls defining laterally opening charge inlet cavities individual to the respective cylinders and a single exhaust cavity common to the respective cylinders, the cylinders having ports opening into the respective cavities, said exhaust cavity ports and the oppositely positioned transfer cavity ports being drilled from the exhaust port cavity at an oblique angle to the cylinder walls whereby the transfer port is offset toward said crank case housing, and closure means operatively connected with said casting for the closure of the cylinders, the jacket space and said cavities, the closure means for the charge admission cavity comprising a carbureting device.

11. In an engine having a vertical crank shaft and horizontally reciprocable pistons in operative connection with the crank shaft, the combination with two crank case parts joined in a transverse plane at the crank shaft to provide upper, lower and intermediate bearings therefor and separate crank cases between the bearings, cylinders in which said pistons are reciprocable, said cylinders being formed in a single cylinder-

block casting of which the crank case section contiguous thereto is a part, a jacket likewise comprising a part of said casting and spaced from said cylinders to provide a jacket space for coolant about the cylinders, said jacket space and cylinders opening to the end of the casting opposite the crank case, means likewise forming an integral part of said casting providing separate transfer passages opening with unobstructed wall surfaces from the respective crank cases of said crank case section and extending thence along the sides of the respective cylinders, said cylinders being provided with ports opening from said passages into the cylinders, means at the sides of said cylinders opposite said transfer passage means comprising spaced laterally projecting walls defining laterally opening charge inlet cavities individual to the respective cylinders and a single exhaust cavity common to the respective cylinders, the cylinders having ports opening into the respective cavities, the exhaust ports and the oppositely disposed transfer passage ports being in axial alignment in oblique relation to the cylinder walls, a cylinder head comprising a closure for the respective cylinders and the jacket space about the cylinders, and a closure connected with the side of the casting over said mixture admission cavity and said exhaust cavity and provided in communication with the respective cavities with a carbureting device and an expansion chamber, said last mentioned closure being formed to provide an internal jacket space intervening between the expansion chamber and the carbureting device and communicating with the jacket space of said engine at a plurality of points to afford circulation of coolant.

12. In an engine, the combination with a cylinder having laterally extending walls defining intake and exhaust cavities, said cylinder having port means affording communication with the respective cavities, of a closure plate provided with spaced chambers communicating with the respective cavities and an intervening partition out of registry with the wall means of said cylinder intervening between said cavities, and a plate intervening between said wall means and said closure and provided with apertures affording communication between the respective cavities, said plate having a cover portion spanning the offset between the partition of said closure and the wall of said cylinder intervening between said cavities.

13. A multi-cylinder engine comprising the combination with a crank shaft, connecting rod and pistons, of a crank case comprising two sections joined at said crank shaft and provided with upper, lower and intermediate bearings defining separate crank cases, a cylinder block comprising in a single casting a plurality of separate cylinders and the adjacent crank case section, and transfer means from the respective crank cases to the respective cylinders and jacket means for said cylinders, said cylinder block also having at its side opposite said transfer means charge admission cavities communicating with the respective cylinders and an exhaust manifold cavity communicating with each of said cylinders and providing an exhaust passage common thereto, said casting having laterally projecting wall surfaces and intervening partition means integrally forming said several cavities and being provided with holes opening through one of said wall surfaces from the jacket space of said cylinder within said jacket means at a plurality of points adjacent remote sides of the respective cylinders, and closure means for the several cavities comprising charge forming means communicating with the charge admission cavities of the respective cylinders, expansion chamber means communicating with said manifold cavity and having an intervening jacket space disposed between the charge forming means and the expansion chamber means and communicating through said holes at spaced points with the jacket space of said cylinder block casting.

14. In an engine, the combination with a cylinder block casting including a crank case part integrally providing for one crank shaft bearing and provided with a closure providing for another crank shaft bearing, of jacket means integrally forming a part of said casting and spaced therefrom at opposite sides of the casting, said jacket means having finished lateral surfaces, and an internal cavity opening smoothly and unobstructedly toward said surfaces for the lateral retraction of dies used in the die casting of said cylinder block, together with closures applied laterally to said casting in connection with said jacket means to confine a coolant therein about the cylinder of said casting.

15. In an engine, the combination of a casting integrally providing a cylinder and a jacket space opening smoothly and unobstructedly about said cylinder toward opposite sides thereof to facilitate the retraction of dies used in making said casting, of opposing closures for said jacket space connected with opposite sides of the casting, and a rib integral with said casting and abutted by one of said closures and constituting a flow directing means for controlling the circulation of coolant within the jacket space.

16. In an engine having a die cast cylinder block, the combination with a cylinder casting having cylinder admission and exhaust passages on two sides communicating with the cylinder and having jacket spaces opening oppositely to the other two sides, said jacket spaces and passages having walls smoothly and uninterruptedly opening outwardly from the cylinder to facilitate the withdrawal of dies, and closures applied to the four sides of the cylinder casting in registry with the respective passages and spaces.

17. In an engine, a die cast cylinder block comprising a cylinder, an integral jacket wall spaced from the cylinder at opposite sides thereof, the space between the jacket wall and cylinder opening smoothly and uninterruptedly in opposite directions to the sides of the casting to facilitate the withdrawal of dies used in forming said space, and opposed closures connected to said casting to confine a coolant within the jacket space.

18. In an engine, a die cast cylinder block providing a horizontal cylinder and integral jacket walls connected with said block and spaced upwardly and downwardly from the cylinder to provide a jacket space opening laterally at opposite sides of the cylinder, the casting being approximately rectangular in cross section, and closures applied to said jacket walls at the sides of said block and in spaced relation to said cylinder to confine a coolant about said cylinder.

19. An engine comprising a die-cast cylinder block, having formed integral therewith, a crank case section and a fuel tank section, said fuel tank section having a cavity partially surrounding the crank case section and a lower portion of the cylinder block.

20. In a horizontally disposed engine, the com-

bination with a single die casting uniterily comprising a cylinder block having a laterally opening cylinder cavity, a crank case section having a vertically opening crank case cavity and a fuel tank section having an upwardly opening fuel reservoir cavity, of closures applied to said casting about the several cavities aforesaid.

21. In an engine subject to tilting and having an underwater exhaust, the combination with a cylinder having an exhaust port and an expansion chamber with which the exhaust port communicates, of a flange surrounding said exhaust port and constituting a dam for trapping in the expansion chamber water running through the expansion chamber toward said port.

22. In an engine, the combination with an upright crank shaft and a horizontally reciprocable piston in operative connection therewith, of a cylinder in which said piston is reciprocable, a crank case provided with bearings for the crank shaft, a portion of said crank case being integral with said cylinder, and a fuel reservoir integral with said crank case portion and extending partially about the crank case, a closure for said reservoir, a flywheel on said crank shaft, and a shroud for said flywheel of which at least a portion is mounted on said closure.

WARREN C. CONOVER.

July 15, 1941. K. LÖHNER 2,249,319

DEVICE FOR COOLING AIR-COOLED INTERNAL COMBUSTION ENGINES WITH THE CYLINDERS ARRANGED IN ROWS

Filed Nov. 1, 1938 2 Sheets-Sheet 1

Fig. 1

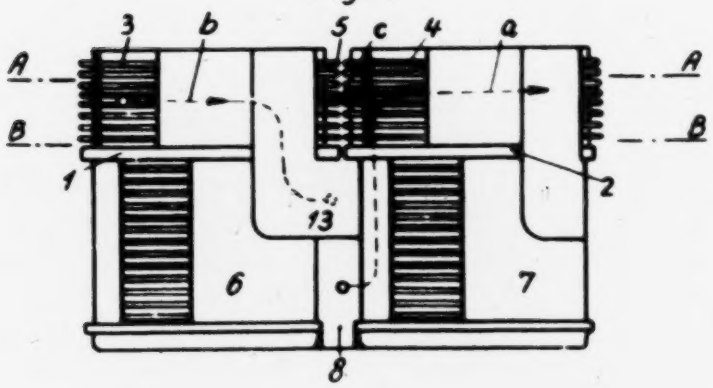


Fig. 2

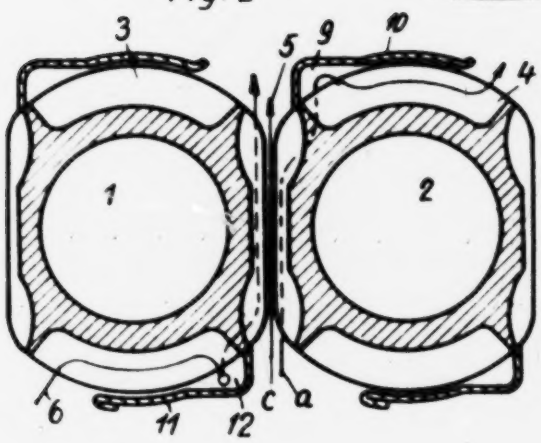


Fig. 4

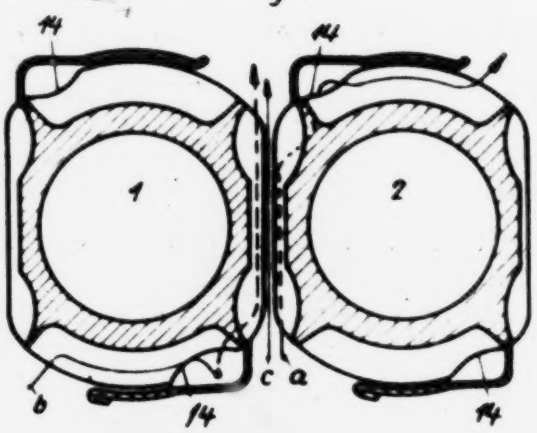
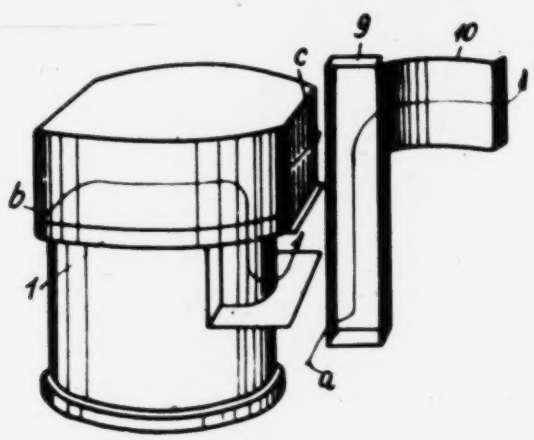


Fig. 3



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DEVICE FOR COOLING AIR-COOLED INTERNAL COMBUSTION ENGINES WITH THE CYLINDERS ARRANGED IN ROWS

Filed Nov. 1, 1938 2 Sheets-Sheet 2

Fig 6

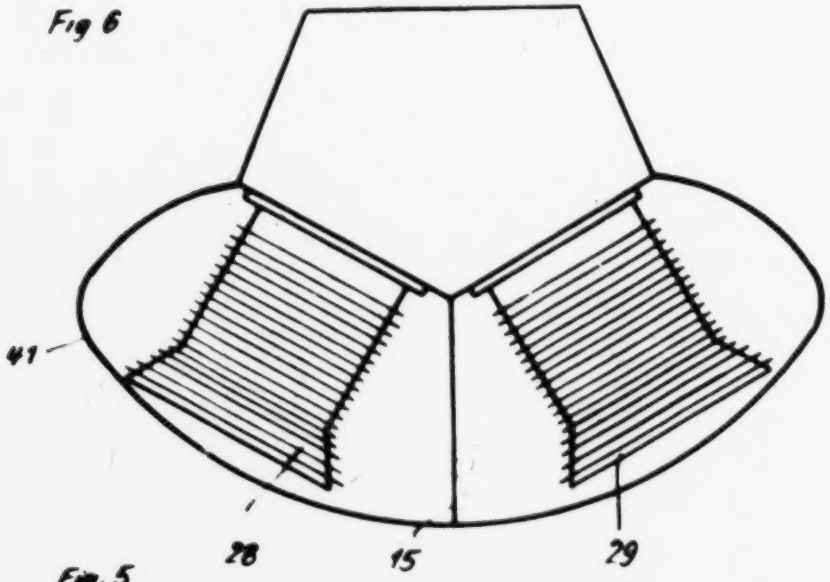
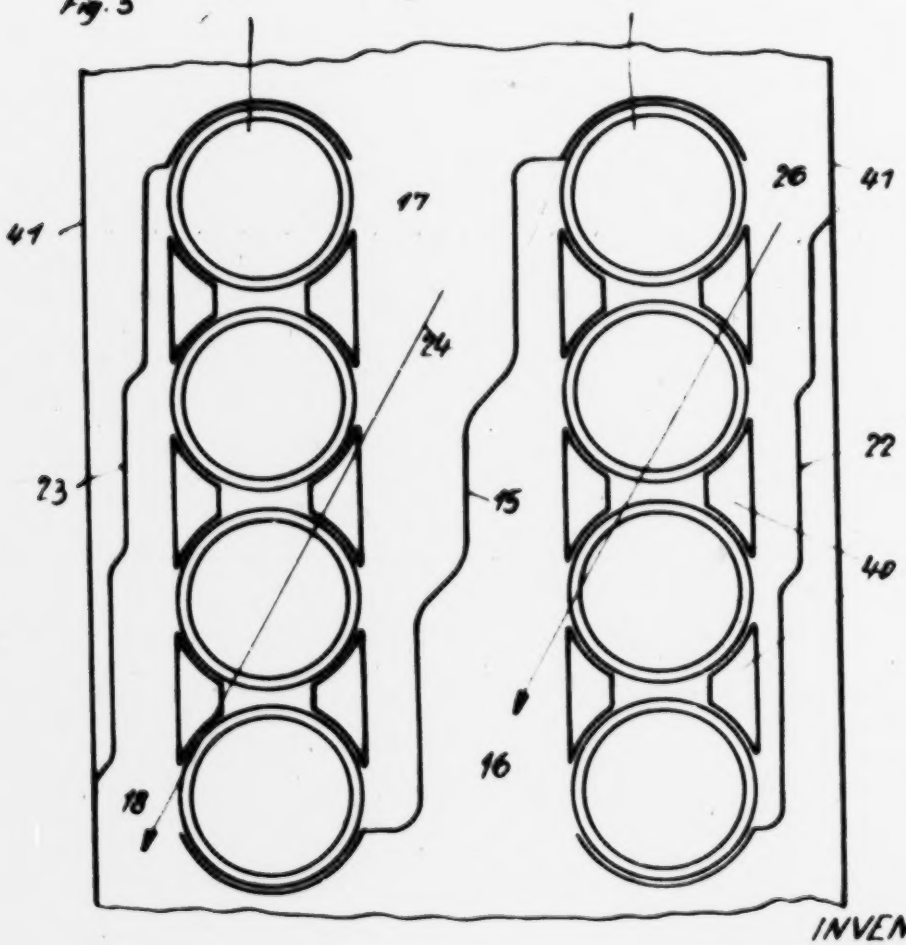


Fig. 5



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UNITED STATES PATENT OFFICE

2,249,319

DEVICE FOR COOLING AIR-COOLED INTERNAL COMBUSTION ENGINES WITH THE CYLINDERS ARRANGED IN ROWS

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Application November 1, 1938, Serial No. 238,137
In Germany July 28, 1937

4 Claims. (Cl. 123—171)

The subject of the present invention is an improvement in or modification of the arrangement for cooling air cooled internal combustion engines with the cylinders arranged in rows, and is a continuation-in-part of my co-pending application Serial No. 238,136, filed November 1st, 1938.

According to my above identified prior application, the spaces between adjacent cylinder rows are sub-divided into inflow and outflow spaces by guide plates so that from the partial spaces formed within each cylinder row intermediate space, one serves for guiding the cooling air flowing to the cylinders, and the other for guiding the cooling air flowing from the cylinders. The cooling air in this case passes from one partial space with the inflowing cooling air between the separate cylinders to the other side of the cylinder row into a partial space with outflowing air. A further feature resides in the fact that the cooling air stream of one cylinder row is so divided by dividing plates into a stream passing around the cylinder heads and the stream passing around the cylinder bases that each cylinder row has the cooling air passing over it from two sides in substantially inclined yet approximately parallel main directions of flow intersecting one another along each cylinder row in a plane at right angles to the cylinder row. The advantage of this cooling arrangement is the complete utilisation of the cross-sectional areas between the separate cylinder rows for the inflow and outflow of the cooling air and thus an increase of the effective quantity of cooling air.

The present invention also provides for a complete utilisation of the cross-sectional areas between the separate adjacent cylinders of the same cylinder row for the inflow and outflow of cooling air by a suitable arrangement of guide means.

In the case of air-cooled internal combustion engines with the cylinders arranged in rows, attempts have been made, in order to reduce the length and the weight as much as possible, to arrange the separate cylinders within the row as closely together as possible. In general, greater wall thicknesses and deeper cooling fins are required for the cylinder head, consisting of aluminium, to enable the withdrawal of heat to be carried out and in order to obtain sufficient strength, than for the cylinder running sleeve which consists of steel. The minimum distance between the separate cylinders is therefore determined by the diameter of the cooling fins of the cylinder heads.

For thermo-technical reasons the cooling fins provided on the steel running sleeve are lower than those provided on the aluminium cylinder head. There is thus formed a free space under the cylinder heads which are arranged close to one another, between the cylinder bases of each two adjacent cylinders.

This free cross-sectional area is utilised in accordance with the invention for cooling the cylinder heads. As a result the height of the cooling fins of the cylinder heads at the points at which two cylinders meet is made substantially lower than the height thereof at the sides of the cylinder row, and in this manner there is obtained as compact a construction of the engine as possible.

The utilisation of this free cross-sectional area is effected in accordance with the invention as follows:

The cooling air is supplied from the side to the cylinder row in any suitable manner, for example by means of guide plates, approximately at right angles to the central plane of the cylinder row.

One half of the free cross-sectional area is utilised according to the invention so as to bring fresh air backwardly in a direction looking transversely to the central plane of the cylinder row, where it is conducted upwardly through a flue and from here is guided along the rearward fins of the cylinder head thus cooling these fins.

On the side of the cylinder turned towards the supply side for the cooling air, looking in the same direction as before, that is to say on the front side of the cylinders, the cooling air is guided in the reverse direction. In this case the fresh air is firstly guided along the front fins of the cylinder head. Thereupon it is conducted through a flue downwardly and from here rearwardly through the second half of the free cross-sectional area between the cylinder bases.

In this manner the cooling air, which passes between the cooling fins between two adjacent cylinder heads at the point of connection, only has to cool these cooling fin parts whereby these may be made much lower than usual. At this point the fresh cooling air only flows for a short distance over the cooling fins. Consequently it can take up very many more heat units, and conduct them away, than a cooling air which has already been heated over a long distance.

By guiding the cooling air in accordance with the invention even cooling fins of low height are sufficiently cooled.

Further, in consequence of their low height the distance between these fins may be made ex-

tremely small by forming them for example by milling instead of by casting.

The guide means, which separate the various air streams, also provide an additional cooling surface.

In comparison with the previous state of engine technology, there is obtained, by means of the invention, a considerable improvement in that in the case of air-cooled internal combustion engines with the cylinders arranged in rows, the separate cylinders of each row can be placed very close together and thus the length of the entire engine is considerably shortened. By shortening the length the weight of the engine and thus the very important specific weight of the engine, particularly in connection with air craft engines, is reduced.

These and other features of the invention will be best understood and appreciated from the following description of a preferred embodiment thereof, described for purposes of illustration and shown in the accompanying drawings, in which:

Fig. 1 is a side elevation of two cylinders in a row, embodying the cooling passages and channels formed in accordance with this invention;

Fig. 2 is a cross-sectional view along the line A—A of Fig. 1;

Fig. 3 is a perspective view of one cylinder and part of the air guiding means of the next succeeding cylinder in a row, showing the path of the directed cooling air;

Fig. 4 is a cross-sectional view along the line B—B of Fig. 1;

Fig. 5 is a longitudinal cross-section illustrating the manner in which the oncoming cooling air is laterally directed against the rows of cylinders as originally disclosed in my above identified copending application Serial No. 238,136; and

Fig. 6 is a transverse cross-sectional view taken through Fig. 5.

The present invention is concerned with construction involving the cooling of a plurality of cylinders aligned in one or more rows, including V-engines, radial engines, etc., and in which the cooling air is directed laterally along the rows of cylinders by means such as illustrated by way of example in Figs. 5 and 6 and described in more detail hereinafter. Figs. 1 to 4 inclusive pertain particularly to two adjacent cylinders of a row to be cooled, said cylinders being provided with enlarged head portions having cooling fins 3 and 4 of normal size along their outer edges, and narrower cooling fins 5 in between them, whereby the cylinders may be positioned much closer to one another than in the usual case. This advantageous construction, is brought about in a manner to be explained hereinafter, without any resultant loss in effective cooling of the cylinder head.

Since the cylinder bases 6 and 7 are of smaller diameter than the cylinder heads, there remains between them an open space 8. By suitable attached means forming a flue 9 and guiding plate 10, the stream of air a directed laterally against the lower portion of the open space 8, is guided upwardly on the far side of the second cylinder 2 and then forwardly through the cooling fins 4 on the far side of this cylinder head. By this means, and by similar means positioned on all of the cylinders of the row, effective cooling of this side of the cylinder heads is in all cases assured.

By means of a second guiding plate 7 and a downwardly guiding flue 12 another part of the laterally directed cooling air stream b is used for cooling the near side of the cylinder head. The air after being heated by contact with the cooling fin which is on the near side of the cylinder head, is guided downwardly by the flue 12 and then the heated air passes through the upper portion 13 of the space between the cylinder bases. It will be thus seen that the space between the cylinder bases which otherwise would not be fully used is effectively entirely utilized for cooling the far and near sides of the cylinder head. This leaves the third part of the laterally directed air stream c for solely cooling the cylinder head along the part intermediate adjacent cylinders. Since this cooling stream c is used for no other purpose and is not heated to a material extent before contact with the cooling fin 5 a very effective and efficient cooling is obtained at this point. Because of the effectiveness of the above described cooling arrangement, the fins 5 may be made smaller, thus permitting a closer mounting of the cylinders, thereby in turn reducing the effective length of the engine.

In order to maintain a full constant cross-sectional area within the flues 9 and 12, the cooling fins 3 and 4 of the cylinder heads may be bent or cut away at an angle at these points, as is best shown in Fig. 4, where the reference numeral 14 shows the cut-away portion.

The cylinder bases are enclosed in regular jacket guide plates, which, however, in no manner interfere with the aforedescribed arrangement for cooling the cylinder heads. The cooling fins 5 between adjacent cylinders may be formed in any well known manner, and, due to their small side, may merely be grooves which have been milled or otherwise cut into these parts of the cylinder heads.

The manner of attaching the various guiding means 9, 10, 11 and 12 is of no particular importance with respect to this invention. They may be either produced in the usual manner from sheet metal, or may be applied as cast, machined or un-machined parts of the cylinder.

As the means for directing the air laterally against the sides of the cylinder rows, the construction illustrated in Figs. 5 and 6 may be used. This construction was originally disclosed and described in my aforesaid co-pending application. As is there illustrated, the space between the cylinder rows 28 and 29 is divided by a guide plate 15 into two partial spaces 16 and 17, the one space 17 serving for directing the air laterally against the cylinder row 28, while the space 16 is used for conducting the air away from the cylinder row 29. The invention has been illustrated as applied to a V-engine of two cylinder rows, which are covered by a general casing member 41. Additional guide plates positioned between the cylinder rows and the casing are illustrated at 22 and 23. The guide plate 22 directs the air 26 laterally against the cylinder row 29, while the guide plate 23 forms a partial space 18 to conduct the heated air 24 away from the cylinder row 28. If the principles of the present invention are applied to the construction illustrated in Figs. 5 and 6, the means illustrated at 40 for guiding the air about the cylinders will be replaced by the guiding means of the present invention. In the case of a radial engine, the outer casing member 41 will not be present, and the guiding means between the heated row of cylinders will be formed similarly to the guiding

plate 15. It is pointed out, however, that the principles of the present invention are not intended to be limited for use in connection with the arrangements illustrated in Figs. 5 and 6, but will be applicable to any arrangement wherein means are provided for laterally directing cooling air against the rows of multiple cylinders.

Having now thus described the invention, and the specific embodiment thereof, as well as the function and mode of operation of the same, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In an internal combustion engine of the class provided with rows of more than one cylinder each, said cylinders being each provided with a finned base portion, an enlarged finned head portion, and means for directing cooling air laterally against a row of cylinders, the combination of a first guide means on each cylinder head for guiding said directed air along one side of said head, and then downwardly and transversely through a portion of the space between the cylinder bases, and second guide means for conducting the cooling air flowing through the remaining portion of the space between the cylinder bases upwardly and forwardly along the opposite side of the head of the next cylinder, whereby the air directed laterally between adjacent cylinder heads is utilized entirely for cooling these cylinder head sides.

2. The combination according to claim 1, in which the cooling fins on the cylinder heads between adjacent cylinders of the same row are shorter than those on the sides of the cylinders.

3. In an internal combustion engine of the class provided with rows of more than one cylinder each, said cylinders being each provided with a finned base portion, an enlarged finned head portion, and means for directing cooling air laterally against a row of cylinders, the combination of a first guide plate and connecting flue for receiving the laterally directed air, guiding it forwardly along the near side of one cylinder head and then downwardly and transversely through a portion of the space between the cylinder bases, and a second flue and guiding plate for receiving the laterally directed cooling air through the remaining space between the cylinder bases, and thence guiding it upwardly and forwardly along the far side of the next cylinder head, whereby the laterally directed air between adjacent cylinder heads is used entirely for cooling said head along the transverse sides thereof.

4. The combination according to claim 3, in which the fins on the cylinders within the flues are inclined in such a manner as to maintain a constant cross-sectional area throughout said flues.

KURT LÖHNER.

Sept. 16, 1941. J. MOLNAR 2,256,002

TOY AIRPLANE MOTOR

Filed May 2, 1940 2 Sheets-Sheet 1

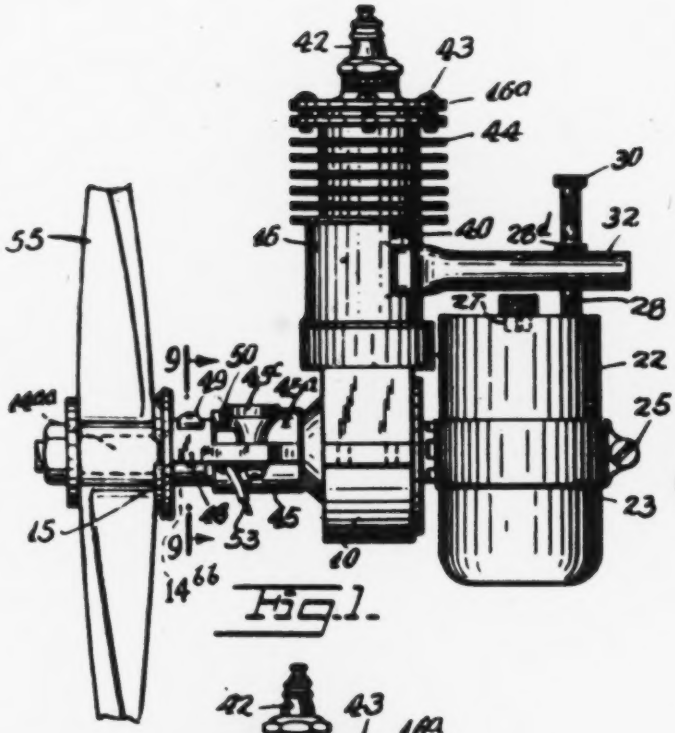

Fig. 1.

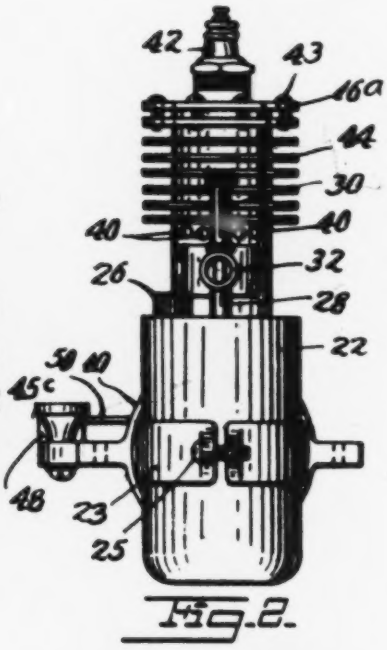

Fig. 2.

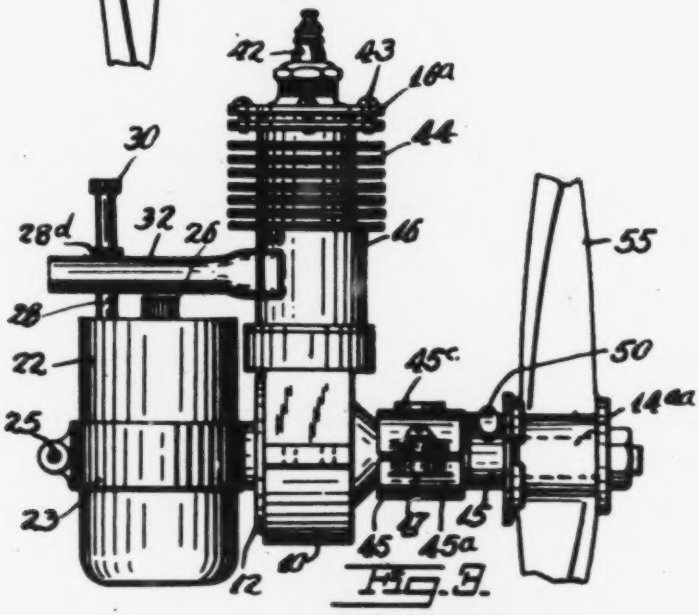

Fig. 3.

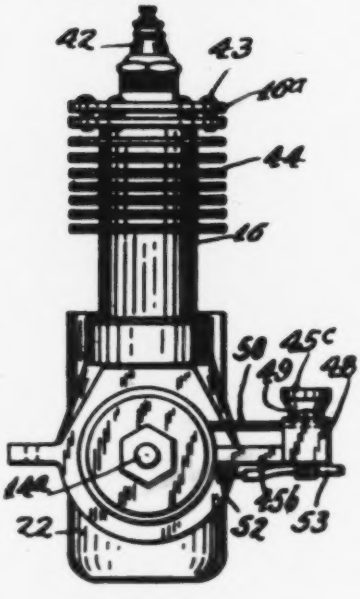

Fig. 4.

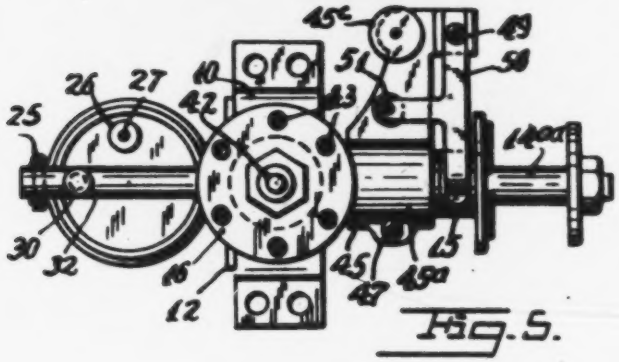

Fig. 5.

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TOY AIRPLANE MOTOR

Filed May 2, 1940 2 Sheets-Sheet 2

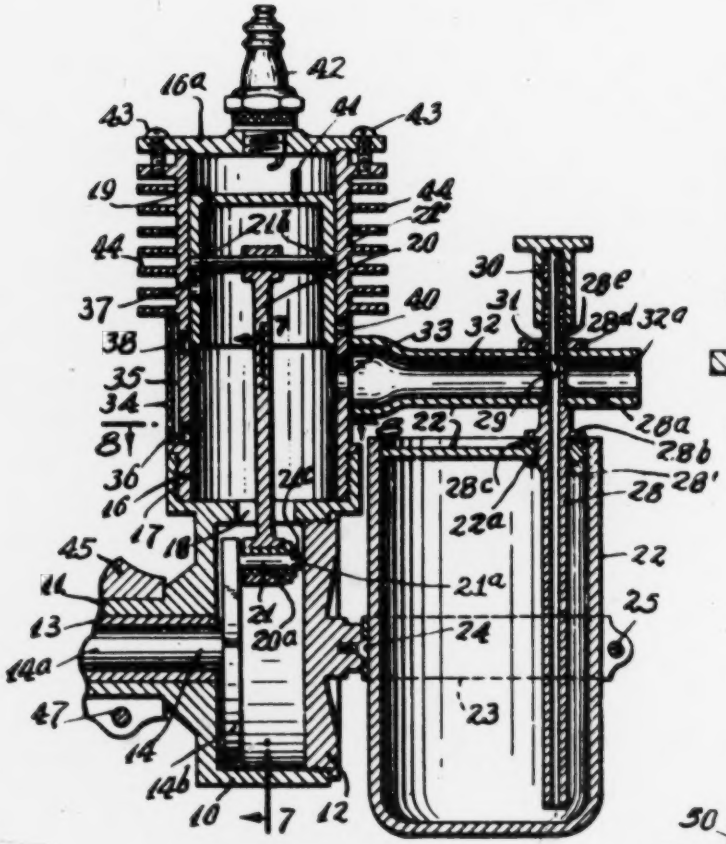

Fig. 6.

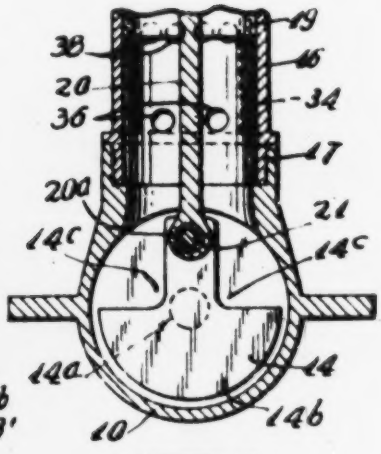

Fig. 7.

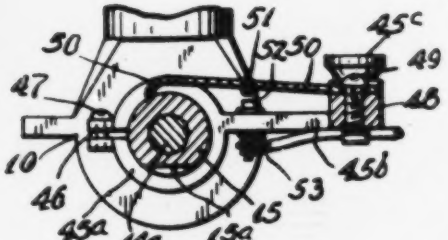

Fig. 9.

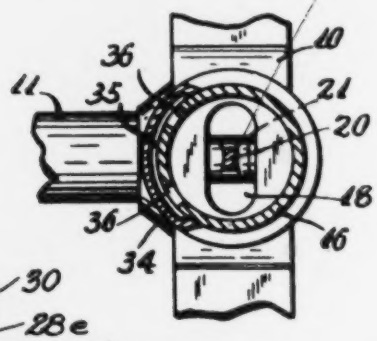

Fig. 8.

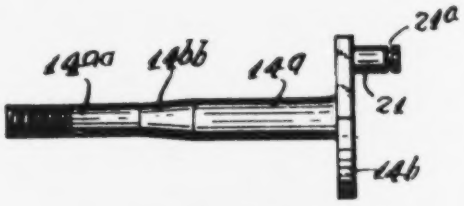

Fig. 10.

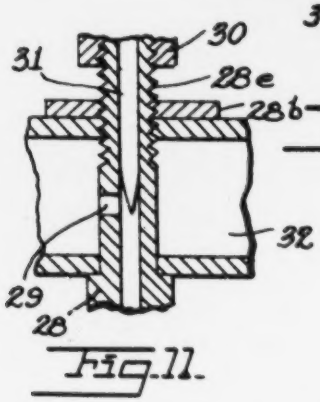

Fig. 11.

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2,256,002

UNITED STATES PATENT OFFICE

2,256,002

TOY AIRPLANE MOTOR

Joseph Molnar, Trenton, N. J.

Application May 2, 1940, Serial No. 332,936

3 Claims. (Cl. 123—73)

This invention relates to new and useful improvements in a toy airplane motor.

The invention has for an object the construction of a toy airplane motor adapted to be operated by gasoline or similar fuels and constructed in an extremely simple manner.

More specifically, the invention proposes to characterize the toy airplane motor by an air tight crankcase having a tubular member on one side through which the crank shaft is rotatively supported, and an arrangement whereby the incoming fuel is sucked into the crankcase to be better carbureted.

The invention also proposes a carburetor comprising an air intake tube through which a fuel tube controlled by a needle nozzle is passed to supply air and fuel to a port formed in the side of a cylinder for the motor.

Still further the invention contemplates arranging the cylinder of the motor in a particular manner and associating it with the crankcase and carburetor device in an extremely simple fashion.

Still further the invention contemplates the provision of a novel make and break arranged in a manner so that the ignition spark may be advanced and retarded in an extremely simple way.

For further comprehension of the invention, and of the objects and advantages thereof, reference will be had to the following description and accompanying drawings, and to the appended claims in which the various novel features of the invention are more particularly set forth.

In the accompanying drawings forming a material part of this disclosure:

Fig. 1 is a side elevational view of a toy airplane motor constructed in accordance with this invention.

Fig. 2 is an end elevational view looking from the right hand end of Fig. 1.

Fig. 3 is a rear elevational view of Fig. 1.

Fig. 4 is an end elevational view looking from the left hand end of Fig. 1 with the propeller removed.

Fig. 5 is a plan view of Fig. 3.

Fig. 6 is a fragmentary enlarged transverse vertical sectional view of a portion of Fig. 1.

Fig. 7 is a fragmentary vertical sectional view taken on the line 7—7 of Fig. 6.

Fig. 8 is a fragmentary horizontal sectional view taken on the line 8—8 of Fig. 6.

Fig. 9 is a transverse vertical sectional view taken on the line 9—9 of Fig. 1.

Fig. 10 is a side elevational view of the crank shaft.

Fig. 11 is an enlarged detail view of a portion of Fig. 6.

The toy airplane motor, according to this invention, includes an air-tight crankcase 10 having a tubular member 11 on one side. The other side of the crankcase is closed with a plug 12 which is threadedly engaged in position. The tubular member 11 is provided with an "Oilite" oil cushion bearing bushing 13. A crank shaft 14 is rotatively engaged through the tubular member 11 and its bushing 13. This crank shaft comprises a shaft proper 14a having a disc portion 14b mounted on its inner end. This disc portion is cut out at the two sides 14c so as to counterbalance the piston rod and piston during operation of the motor.

A cam 15 is mounted on an outer portion of the crank shaft 14 immediately adjacent the outer end of the tubular member 11 on a tapered portion 14bb of the crank shaft. This tapered portion is formed to maintain the compression and vacuum in the crankcase 10, also to permit the setting of the cam in various desired positions, and by so doing the timer, which will be described hereinafter, may also be used in various set positions, such as in the horizontal or vertical positions. A cylinder 16 is mounted on the crankcase 10. The adjacent portions of these parts, cylinder and crankcase, are formed with threads 17 by which they are connected. The cylinder 16 has a bottom opening 18 connecting the interiors of the cylinder and crankcase together. A hollow piston 19 is disposed within the cylinder 16 and is associated with a connecting rod 20 connected thereto with a pin 21'. This pin is prevented from sliding by a pair of piston pin keys 21b, snapped into suitable openings in pin 21', at the ends of the pin, adjacent the inner wall of the hollow piston 19. The lower end of rod 20 is connected to an eccentric pin 21 mounted on the disc 14b. This pin 21 is surrounded by a flanged brass bearing 20a which is held in position by a split washer or rod key 21c which is adapted to engage and anchor in an annular groove 21a in the eccentric pin 21. This bearing prevents the wear of the connecting rod 20 and pin 21, and may be interchanged whenever desired without removing the entire piston 19 from the cylinder 16.

A small fuel tank 22 is supported by a metallic band 23 secured to the plug 12 by a fastening element 24. The band 23 has its outer end split open, and the end portions thereof are connect-

ed together with a screw 25. This screw may be tightened to make the band grip the tank 22, or may be loosened to release the tank.

The top wall of the tank 22 is provided with a removable plug 26, which when removed discloses an opening through which the tank may be supplied with fuel. This plug has a very small vent opening 27 permitting the passage of air into the fuel tank as gasoline, or the fuel is used up.

A fuel discharge pipe 28 extends into the tank through its top wall and terminates near the bottom of the tank. The discharge pipe 28 is secured to the top 22 of the tank 22 by engaging the threaded opening 22a by the threaded portion 28' of the pipe 28. The pipe 28 is formed with a flange 28b, which engages over the top 22' of the tank 22. A gasket 28c is interposed between the flange 28b and the tank top 22' to prevent evaporation of the fluid stored in the tank. Another nut 28d is adapted to engage a threaded extension 28e of the pipe 28, and by means of this nut, the pipe 28 is secured to the inlet pipe 32. The outer end of this pipe 28 is formed with a reduced portion 28a which has a nozzle opening 29. A bushing 30 is threadedly engaged on the reduced end 28a and is provided with a needle valve 31 operating across the nozzle opening 29 for controlling the passage of fuel.

An air inlet pipe 32 has an open outer end 32a and has a central portion through which the reduced end 28a of the fuel pipe 28 passes. This air inlet pipe 32 connects with fuel inlet ports 33 formed in the side wall of the cylinder 16. These ports 33 are located at a point just beneath the piston 19 when the latter is in its outer position.

The cylinder 16 has a jacket 34 attached on one side dividing off an enclosed passage 35. This passage 35 connects with bottom ports 36 adapted to align with ports 37 formed in the piston 19, when the piston is in its inner position. The passage 35 also has top ports 38 which are just above the top of the piston 19 when the piston is in its inner position.

A spark plug 42 is mounted on the outer end of the cylinder 16. The cylinder 16 has a removable head 16a which is held in position by several fastening elements 43. The upper portion of the cylinder 16 is provided with a plurality of closely spaced fins 44 for air cooling purposes.

A bracket 45 is frictionally turnably mounted upon the tubular member 11 (see Figs. 1 and 6). This bracket 45 has an annular bottom portion 45a which is formed with an open split 46. A fastening element 47 engages through lug portions mounted upon or formed on the material adjacent this split 46. This fastening element 47 is in the form of a screw which may be turned in or slightly let out to control the frictional grip of the bracket upon the tubular member 11.

The bracket 45 is provided with an upwardly extending stem portion 45b. At the top this stem portion is formed with a boss 48 into which a screw 49 threadedly engages. The screw 49 supports a steel spring 50. This spring 50 carries a contact 51 of a make and break. This contact 51 is directly opposite a contact 52 which is mounted on the portion 45a, offset to one side of spring 50 in a position where no oil can splash on these contact points. By this arrangement the contacts 51 and 52 are kept clean from the splashing oil and thus the timing of the spark becomes more dependable than other toy airplane motors. The contact 52 is connected with a cable 53 for the ignition of the airplane motor.

The operation of the airplane motor is as follows:

The plug 26 is removed and fuel is placed in the tank 22. The plug is then replaced. The knob 45c is gripped and the bracket 45 is turned so as to retard the spark. It should be noted that when the bracket 45 is turned on the tubular member 11, the end of the spring 50 will be changed relative to the location of the recess 15a of the cam 15. The motor is now ready to be cranked.

The piston 19 during its upstroke will create suction in the cylinder 16, which will draw in air through the air tube 32. Fuel will also be drawn into this tube through the nozzle opening 29. The incoming fuel will enter beneath the piston 19 into the crankcase. Then the piston 19 moves downwards and this fuel will be forced into the crankcase 10. The fuel is being compressed beneath the piston 19. When the piston reaches its extreme lowered position the ports 36 and 37 align with each other and the compressed fuel is permitted to escape up through the passage 35 and through the ports 38 into the power cylinder to the top of the piston 19.

The piston 19 now starts moving upwards and closes the ports 36. The fuel is completely compressed in the cylinder above the piston. When the fuel is completely compressed and the piston starts moving downwards the spark plug 42 functions to ignite the fuel which then drives the piston downwards under power. When the piston uncovers the ports 40 the burned gases will discharge. The baffle 41 tends to prevent an excess loss of good fuel which enters the cylinder through the ports 38 and which must be restrained from freely discharging out of the ports 40.

After the motor starts running the handle 45c is again gripped and the bracket 45 moved around on the tubular member 11 so as to advance the spark to increase the efficiency of the engine.

While I have illustrated and described the preferred embodiments of my invention, it is to be understood that I do not limit myself to the precise constructions herein disclosed and the right is reserved to all changes and modifications coming within the scope of the invention as defined in the appended claims.

Having thus described my invention, what I claim as new, and desire to secure by United States Letters Patent is:

1. In an airplane motor, an air-tight crankcase having a tubular member on one side, a crank shaft rotative through said tubular member and having a cam adjacent the outer end of said tubular member, a cylinder mounted on said crankcase and having its inner end connected with the interior of said crankcase, a hollow piston in said cylinder and having a connecting rod connecting it with said crank shaft, a small fuel tank mounted on said crankcase and having a fuel discharge pipe with a nozzle opening controlled with a needle valve, an air inlet pipe encasing that portion of the fuel discharge pipe having the nozzle opening and connecting with a fuel inlet port in the side of said cylinder at a point beneath said piston when the piston is in its outer position, said cylinder having a passage with a bottom port aligning with a port in said piston when the piston is in its inner position and having a top port just above the piston in its in-

ner position, said cylinder also having a burnt fuel discharge port just above said top port, and a baffle on the top of said piston for separating the latter ports, said mounting of said fuel tank comprising a band securely encircling said fuel tank, a plug closing the end of said crankcase opposed to said tubular member, and screw passing freely through an opening in said band and threadedly engaging an opening in said plug, said screw having its head sunk so as to be flush with the inside periphery of said band.

2. In an airplane motor, an air-tight crankcase having a tubular member on one side, a crank shaft rotative through said tubular member and having a cam adjacent the outer end of said tubular member, a cylinder mounted on said crankcase and having its inner end connected with the interior of said crankcase, a hollow piston in said cylinder and having a connecting rod connecting it with said crank shaft, a small fuel tank mounted on said crankcase and having a fuel discharge pipe with a nozzle opening controlled with a needle valve, an air inlet pipe encasing that portion of the fuel discharge pipe having the nozzle opening and connecting with a fuel inlet port in the side of said cylinder at a point beneath said piston when the piston is in its outer position, said cylinder having a passage with a bottom port aligning with a port in said piston when the piston is in its inner position and having a top port just above the piston in its inner position, said cylinder also having a burnt fuel discharge port just above said top port, and a baffle on the top of said piston for separating the latter ports, said crankcase being provided with a plug on the side opposite said tubular member.

3. In an airplane motor, an air-tight crankcase having a tubular member on one side, a crank shaft rotative through said tubular member and having a cam adjacent the outer end of said tubular member, a cylinder mounted on said crankcase and having its inner end connected with the interior of said crankcase, a hollow piston in said cylinder and having a connecting rod connecting it with said crank shaft, a small fuel tank mounted on said crankcase and having a fuel discharge pipe with a nozzle opening controlled with a needle valve, an air inlet pipe encasing that portion of the fuel discharge pipe having the nozzle opening and connecting with a fuel inlet port in the side of said cylinder at a point beneath said piston when the piston is in its outer position, said cylinder having a passage with a bottom port aligning with a port in said piston when the piston is in its inner position and having a top port just above the piston in its inner position, said cylinder also having a burnt fuel discharge port just above said top port, and a baffle on the top of said piston for separating the latter ports, said crankcase being provided with a plug on the side opposite said tubular member, said fuel tank being supported by a band mounted on said plug, said band having a split portion frictionally closed with a fastening element.

JOSEPH MOLNAR.

Dec. 15, 1942. B. J. MUENK 2,305,186

ENGINE VENTILATING

Filed June 5, 1940

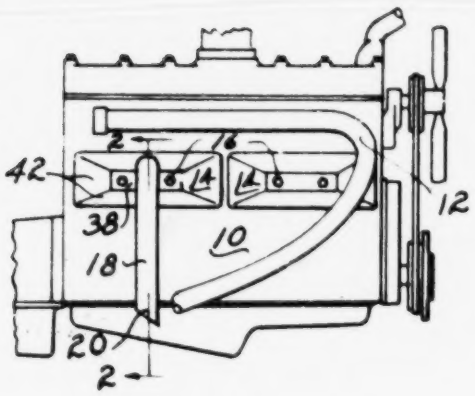

Fig. 1

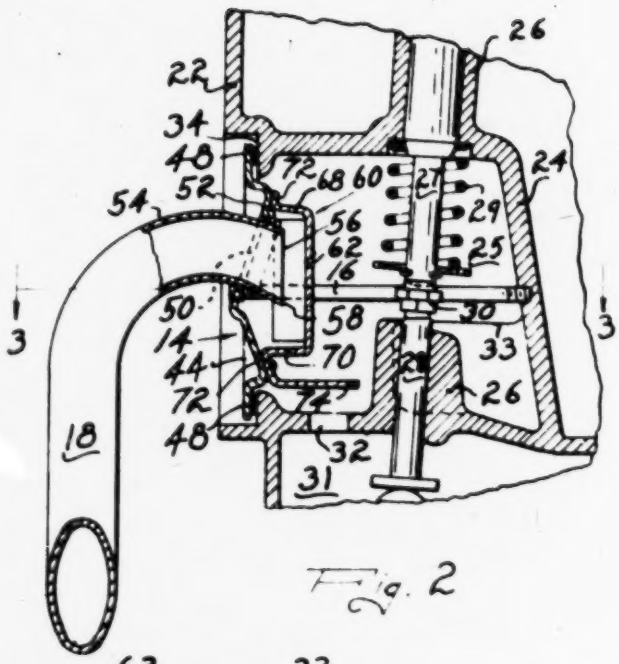

Fig. 2

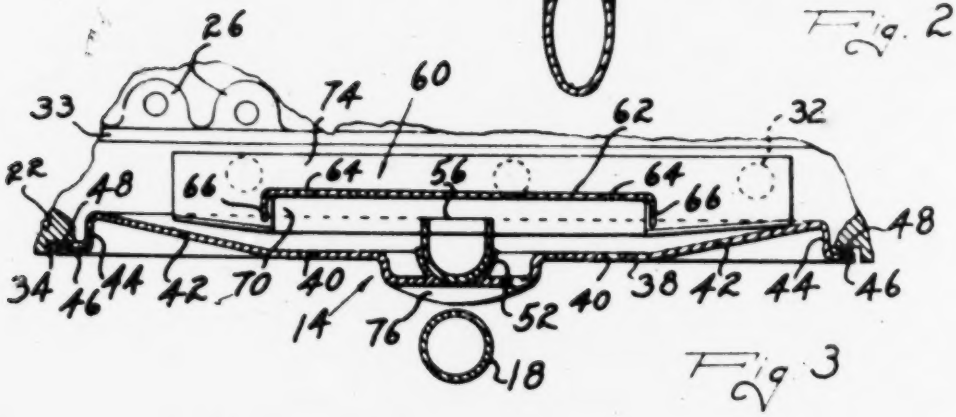

Fig. 3

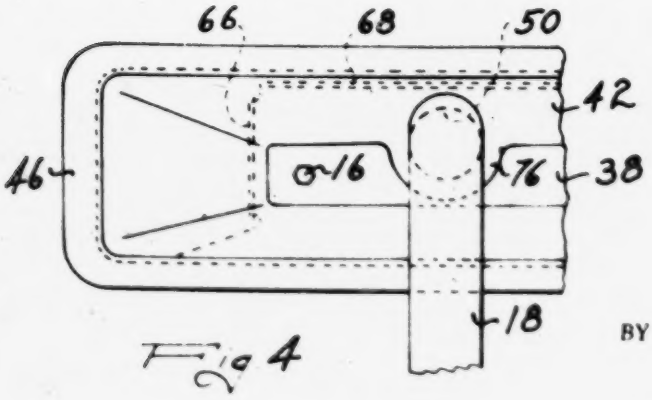

Fig. 4

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Patented Dec. 15, 1942

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2,305,186

ENGINE VENTILATING

Bernard J. Muenk, Kenosha, Wis., assignor to Nash-Kelvinator Corporation, Kenosha, Wis., a corporation of Maryland

Application June 5, 1940, Serial No. 338,865

6 Claims. (Cl. 121—194)

This invention relates to engine ventilators and has particular reference to means for providing a vent from the crank case of an internal combustion engine to the atmosphere outside of the engine.

It is an object of this invention to provide a vent which will adequately remove fumes and air from a crank case without allowing excessive quantities of oil to escape from the engine.

It is another object of this invention to provide novel means for baffling a vent to prevent the escape of oil therethrough.

It is another object of this invention to provide a vent pipe which will act as a condenser to return lubricant to the engine.

Other objects and advantages of this invention will be apparent from a consideration of the following specification and claims and the attached drawing of which there is one sheet and in which—

Figure 1 represents a side elevation of an internal combustion engine;

Figure 2 represents a section taken along the plane indicated by the line 2—2 of Figure 1 and looking in the direction of the arrows;

Figure 3 represents a horizontal section taken along a plane indicated by the line 3—3 of Figure 2 and looking in the direction of the arrows;

Figure 4 represents an enlarged side elevation of a portion of the valve cover plate and breather tube illustrated in Figure 1.

In Figure 1 I have illustrated an internal combustion engine 10 provided with an exhaust pipe 12 and two valve chamber cover plates 14 secured to the engine by means of bolts 16. The rear cover plate 14 is provided with a breather tube 18 for removing dangerous fumes and gases which may blow by the pistons and valves of the engine and collect in the engine. The breather tube 18 extends to a low point beside the engine and is tapered upwardly on the back side as indicated at 20 so that the stream of air thrown backward from the cooling fan will act to draw the fumes out of the tube. The fumes consist of water vapor, exhaust gases and partially burned fuel and air which might explode and would dilute the lubricating oil if allowed to remain in the engine.

More specifically the engine 10 consists of a casting having a side wall 22 (see Figures 2 and 3) which is recessed at 24 to form a valve chamber 25. The top and bottom walls of the chamber 25 are provided with bosses 26 which are apertured to form guides for valve stems 27 and valve push rods 28. Chamber 25 is adapted to house the valve springs 29 and valve adjusting mechanism 30 which are commonly used in automotive construction today. The lower wall of the recess chamber 25 separates the valve chamber from the crank case and cam shaft space 31 which is in open communication with the oil pan and oil storage space (not shown). The lower wall of the chamber 25 is apertured as at 32 to permit oil splash and oil vapors to rise from the crank case chamber 31 to the valve chamber 25 and lubricate the valve guides and valve mechanism. Lubricant is also fed to the valve chamber under pressure where it collects behind dams 33 until it fills up over the sloping tops of the lower bosses 26 to lubricate the push rods 28. Apertures 32 form a return passage for excess oil spilling over the dams 33 to return to the crank case.

The side wall 22 of the engine is shaped to provide a recessed shoulder 34 around the valve chamber 25, which shoulder forms a seat for valve cover plate 14. The valve cover plate functions to keep dust and moisture from the valve mechanism and to prevent the excessive loss of lubricant from the valve chamber 25.

Since the crank case 31 often becomes filled with burned and partially burned gases which blow by the pistons and valves of the engine, particularly in older engines, these gases are free to rise through the apertures 32 into the valve chamber 25, and it has been the practice to provide a breather tube similar to my breather tube 18 through which these gases could escape. However, I have found that in addition to allowing the gases to escape, a considerable quantity of oil and oil vapor is carried out of the breather tube, and it is toward preventing this loss of lubricant to which my invention is directed.

The valve cover plate consists of a stamping having a flat central surface 38 apertured at 40 to provide space for the bolts 16 which are threaded into the inner wall 24 of the valve chamber 25. On all sides of the flat surface 38 the cover plate 14 is bent back in sloping planes 42 which terminate at their outer edges in the outturned flange 44 which is carried continuously around the plate. The flange 44 is turned down in a flat flange 46 which seats against the shoulder portion 34 of the engine to close the valve chamber 25. I have provided a gasket 48 between the flange 46 and the surface 34 to insure a tight seal between the surfaces.

The upper sloping plane 42 which slants downwardly and outwardly to the flat surface 38 is apertured at 50, and the sides of the aperture

are inwardly flanged as at 52. Positioned within the flanged aperture 50 and normal to the upper sloping surface 42 is breather tube 18 which may be secured in the aperture 50 by press fitting or welding and which is formed with an upper curved portion 54. Since the flanged opening 50 is in the surface 42 which slants outwardly from the valve chamber 26, it is apparent that the curved portion 54 of the breather tube will extend first in an upward direction from within the valve chamber and then downward to the lower end of the tube. The inner end of the breather tube 18 is cut off in a vertical plane as shown at 56 rather than in a plane at right angles to the axis of the tube at that point. This construction of the breather tube causes any oil vapors which may be carried into the tube with the combustion gases to impinge upon the walls of the breather tube. Since the greater part of the curved section 54 of the breather tube is outside of the valve chamber 26 and subject to the cooling action of the fan, a great deal of this lubricant vapor will be condensed and will drain back down the curved section of the breather tube to the lip 58 at the lower side of the inner end 56 of the breather tube. Oil vapors condensing within this length of tube 18 will drain to the bottom thereof and will drip off the lower lip, the lowest point on the tube. If the end were cut off square, some drippings might fall directly across the path of the vented vapors and be carried out by the rush of gases.

To further prevent excessive escape of lubricant through the breather tube, I have provided a baffle generally indicated at 60 on the inside of the cover plate 14 and over the mouth 56 of the breather tube 18. Baffle 60 consists of a central flat plate 62 apertured at 64 to pass the bolts 16. The edges of the flat plate 62 are all bent outwardly to form end walls 66, top wall 68, and bottom wall 70. It will be noted that the top wall 68 and bottom wall 70 are slightly longer than the end walls 66 so that the end walls 66 do not touch the cover plate 14 and that the walls are not joined at their corners, thus providing spaces through which the fumes within the valve chamber 26 may pass to reach the breather tube. Upper wall 68 and lower wall 70 are turned over in slanting flanges 72 which are secured to the slanting surfaces 42 of the cover plate as by welding. The lower flange 72 of the baffle is further bent inwardly in an enlarged horizontal baffle 74 which extends over the apertures 32 in spaced relationship therewith to prevent an excessive amount of lubricant from being splashed into the valve chamber by the action of the crank shaft and cam shaft.

From the above description it should be apparent that the fumes being exhausted from the valve chamber 26 together with any entrained lubricant vapor must pass between the sides 66 of the baffle 60 and cover plate 14. From this passage the fumes and vapor move generally horizontally to the mouth of the breather tube, at which point they must change direction and pass through the breather tube. By directing the gases in this path I have decreased the velocity of the gases over the lip 58 so that there is no tendency to pick up and carry out lubricant which has condensed in the curved portion of the breather tube and drained back toward the valve chamber 26. Should the sloping surface 42 of the cover plate 46 be too small to provide space for the aperture 50, the sloping surface 42 may be continued for a short distance by pressing out a portion of the flat surface 38 as is indicated at 76.

While I have described my invention in some detail, I intend this to be an example only and not limiting on my invention to which I make the following claims:

1. A breather device for an engine comprising a cover plate, a breather tube extending in a smooth curve through said plate, first upwardly to a high point on one side of said plate and then downwardly, the end of said tube on the opposite side of said plate from said high point terminating in a vertical plane spaced from said plate, and means positioned adjacent to said last mentioned end for obstructing vertical flow of vapors to said end of said breather tube.

2. A breather device for an engine comprising a cover plate, a baffle plate secured to one side of said cover plate and spaced therefrom, and a breather tube extending through said cover plate and having an end terminating in a vertical plane lying in the space between said cover plate and baffle plate, said tube extending upwardly from said end and having another end which is bent downwardly and terminates below said first mentioned end.

3. A breather device for an engine comprising a cover plate, a channel-shaped baffle plate secured to one side of said cover plate along the top and botton edges of said baffle and having its central portion spaced from said cover plate, said baffle plate having side edges extending toward but terminating in spaced relation to said cover plate, said cover plate and baffle plate together forming an elongated chamber open at its ends, and a breather tube extending from said elongated chamber through said cover plate.

4. A breather device for an engine comprising a cover plate, a channel-shaped baffle plate having flanged top and bottom edges secured to one side of said cover plate, legs on each end of said baffle plate, said legs being narrower than the width of said channel and extending from said baffle plate toward but terminating in spaced relation to said cover plate, and a vent tube supported by said cover plate and extending therethrough and terminating in the space between said baffle plate and cover plate.

5. A breather device for ventilating a chamber having an inlet comprising a cover plate, a breather tube extending through said cover plate, a baffle secured to one side of said cover plate and spaced therefrom, and a flange formed on the bottom of said baffle and adapted to extend completely over said inlet, said baffle extending over one end of said tube.

6. A breather device for ventilating a chamber having an inlet in the lower wall thereof comprising a cover plate adapted to close said chamber, a breather tube extending through said cover plate, a baffle supported by said cover plate in spaced relation therewith and over one end of said breather tube, and a flange formed on said baffle extending completely over said inlet in spaced relation thereto.

BERNARD J. MUENK.

April 11, 1944. A S BOSMA 2,346,148

OUTBOARD MOTOR

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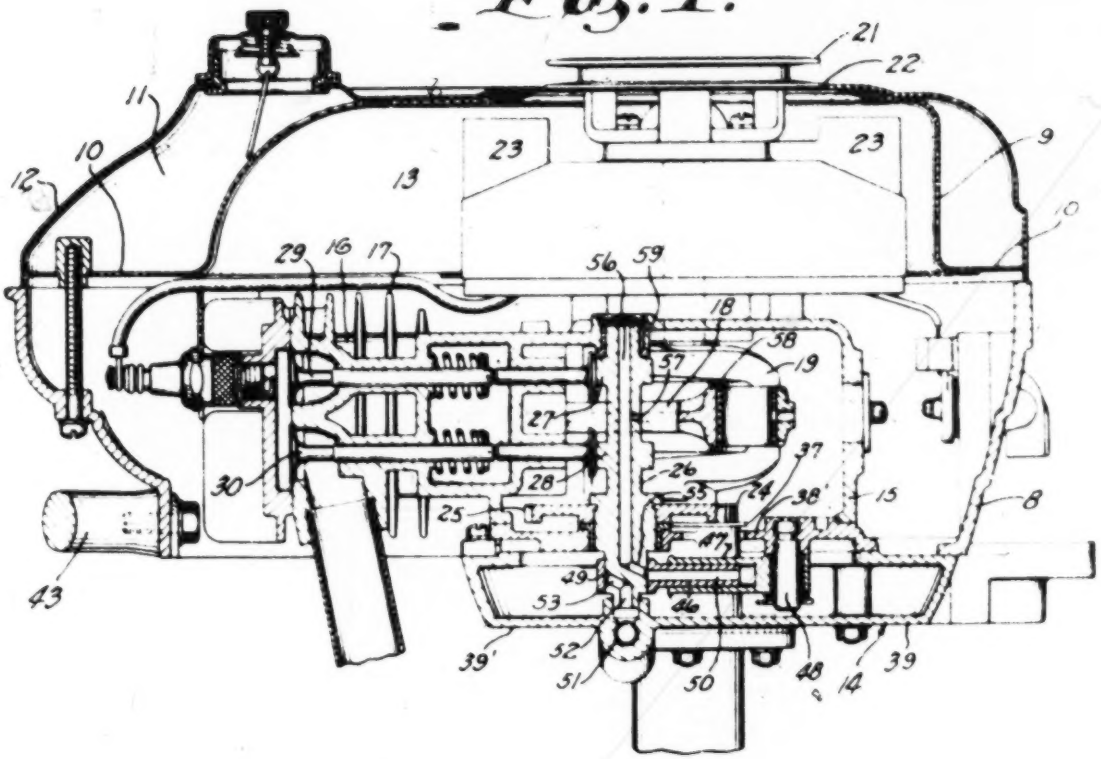
Fig. 1.



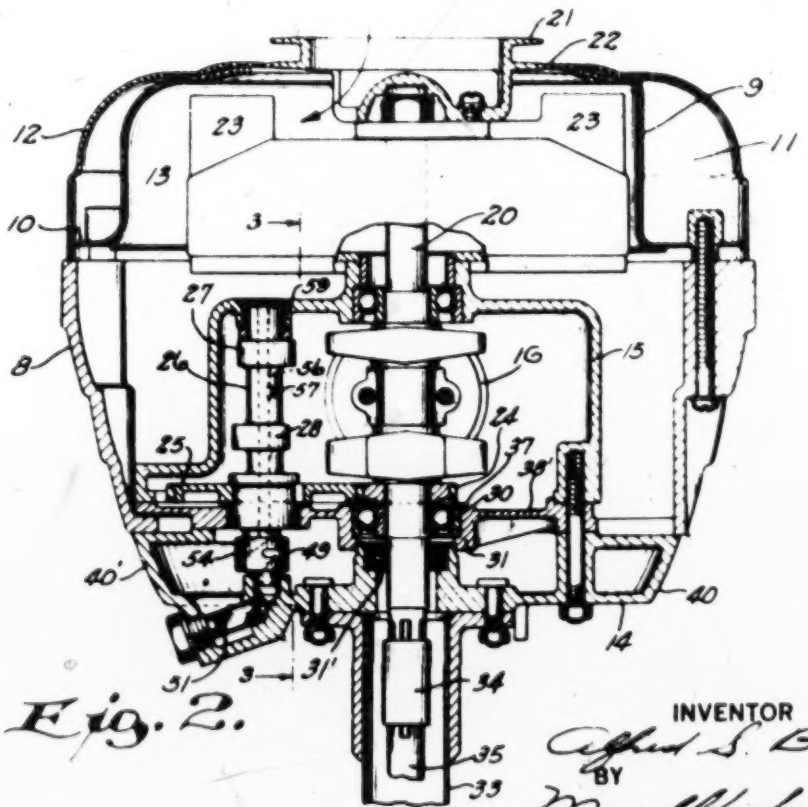


Fig. 2.

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OUTBOARD MOTOR

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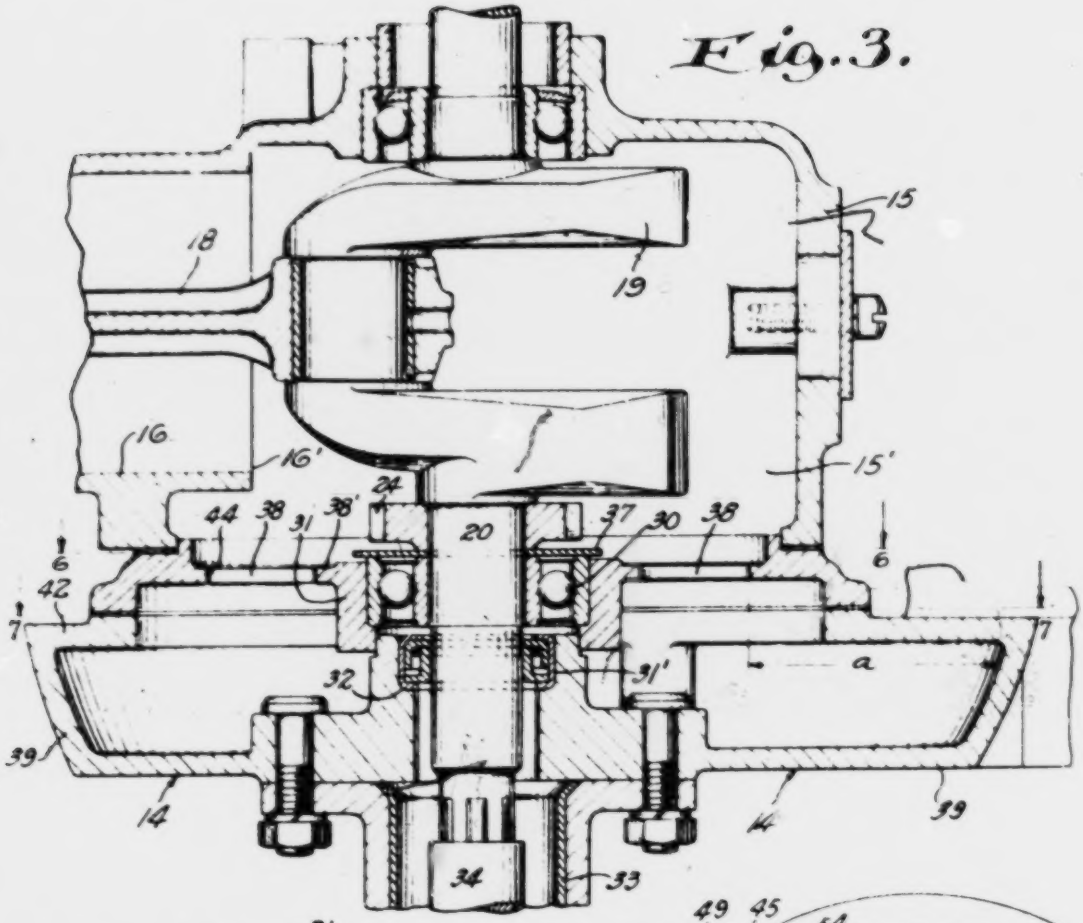
Fig. 3.



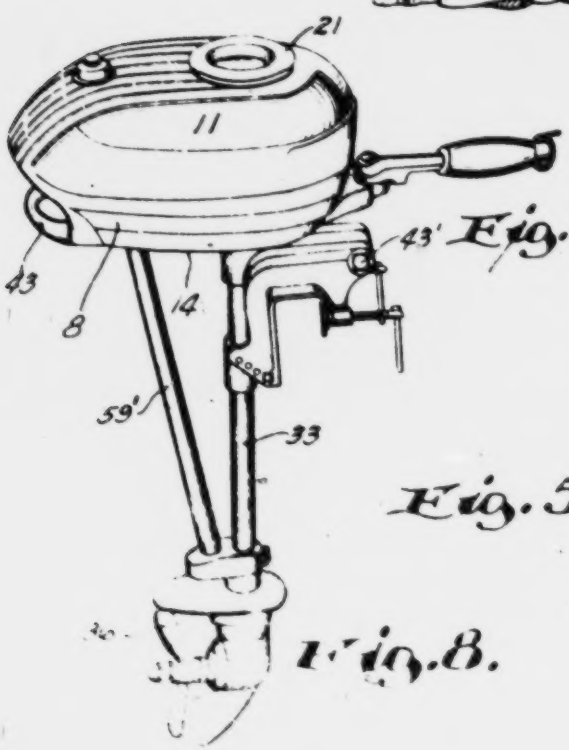


Fig. 4.

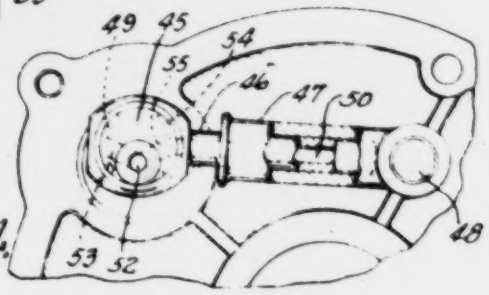


Fig. 5.

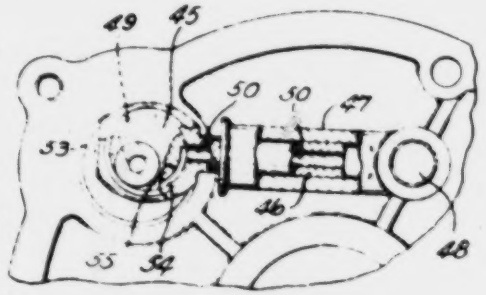


Fig. 8.

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OUTBOARD MOTOR

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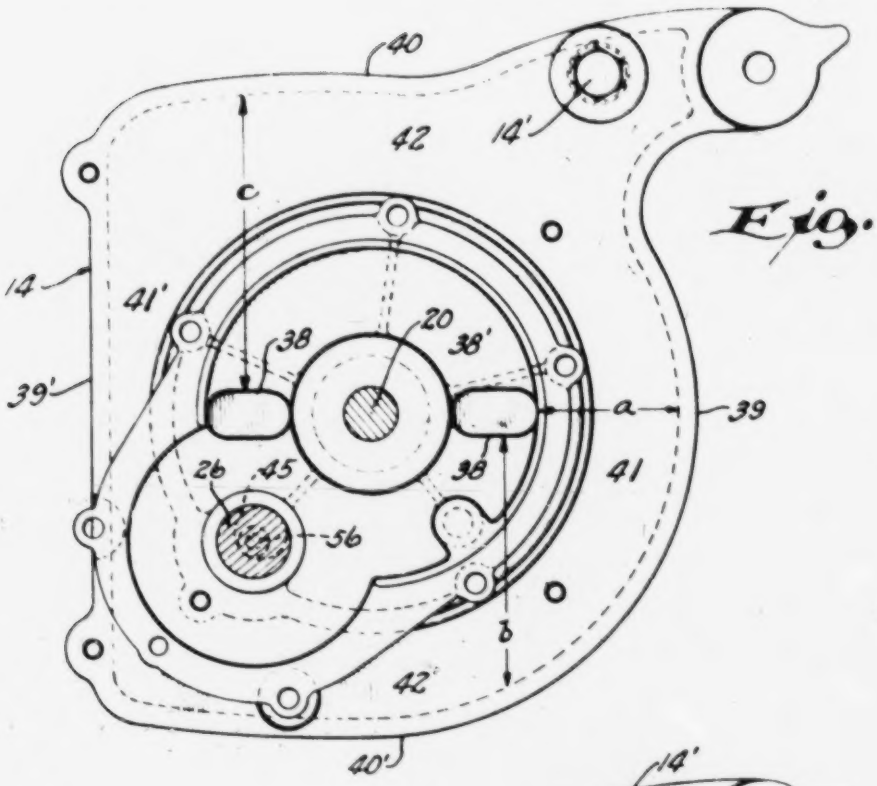

Fig. 6.

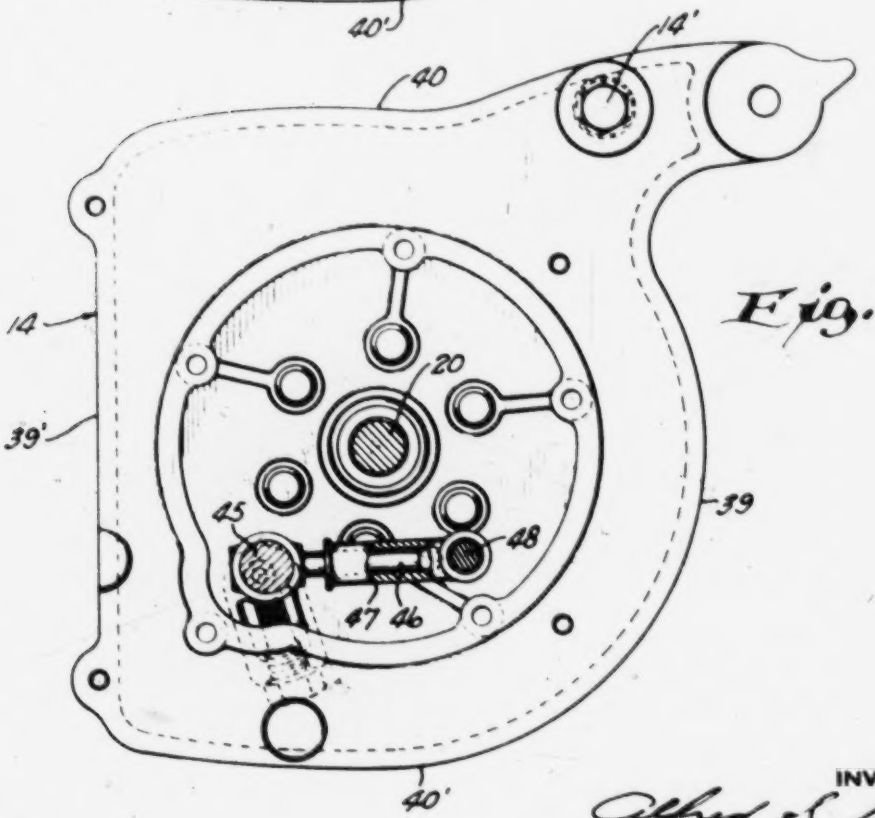

Fig. 7.

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2,346,148

UNITED STATES PATENT OFFICE

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OUTBOARD MOTOR

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Application August 1, 1940, Serial No. 348,053

11 Claims. (Cl. 194—6)

This invention relates to improvements in outboard motors.

Outboard motors as commonly constructed are two cycle and lubricated by mixing a minor quantity of lubricating oil with the gasoline or other fuel in the main fuel tank. This requires the preparation of a special mixture and is otherwise objectionable. It is recognized that greater efficiency and economy in operation can be obtained by the use of a four cycle motor wherein there is a separate oil reservoir and mechanism for feeding said oil to the parts to be lubricated, but oil in a separate reservoir has heretofore presented problems in an outboard motor. One of said problems arises from the fact that an outboard motor is frequently tilted to a horizontal position while on a boat or while being manually carried or placed on its side while being transported in a vehicle. Another problem is that of leakage of oil during operation, particularly leakage past the crank shaft bearing down into the propeller shaft sleeve.

It is, therefore, one of the objects of the present invention to provide an improved four cycle outboard motor construction having a separate oil reservoir and oil feeding means, said reservoir being so located and constructed with reference to the position of operating parts thereabove that the motor may be tilted to all necessary positions or placed on its side without causing oil from the reservoir to enter the cylinder and start trouble, and said reservoir being so located that surplus oil will drain from the bearings back into the reservoir during normal operation.

A further object of the invention is to provide in a construction as above described, means for effectively feeding the oil to the parts to be lubricated.

A still further object of the invention is to provide in an outboard motor having a separate oil reservoir, means operable while the motor is running for forcibly directing surplus oil away from the crank shaft bearing at the bottom of the main motor housing and back into the reservoir, and means for preventing loss of oil through the propeller shaft sleeve.

A further object of the invention is to provide in an outboard motor an improved air cooling construction whereby the necessity of utilizing a water pump is eliminated.

A still further object of the invention is to provide an air cooled outboard motor construction as above described, a fan chamber, and a fuel tank surrounding said fan chamber and serving as a shroud therefor whereby a compact and attractive design is made possible.

With the above and other objects in view the invention consists of the improved motor for outboard and other uses, and all its parts and combinations, and all equivalents thereof.

In the accompanying drawings illustrating one complete embodiment of the preferred form of the invention, and wherein like reference characters designate the same or similar parts in the various views,

Fig. 1 is a longitudinal vertical sectional view through the motor housing;

Fig. 2 is an irregular transverse sectional view through said housing;

Fig. 3 is an enlarged sectional view taken approximately on line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view on an enlarged scale looking up at the oil pump from the bottom of the reservoir and showing the oil pump with its piston duct in registration with the discharge port at the middle of a discharge stroke;

Fig. 5 is a similar view showing the piston near the end of its discharge stroke;

Fig. 6 is a view taken approximately on line 6—6 of Fig. 3 looking down on the reservoir with its cover plate in position;

Fig. 7 is a view taken approximately on line 7—7 of Fig. 3 looking down on the reservoir with its cover plate removed; and

Fig. 8 is a perspective view of the entire outboard motor.

Referring more particularly to the drawings, the numeral 8 designates an exterior housing for the motor proper, the numeral 9 a hood over the housing 8 having an outwardly directed surrounding flange 10 forming the bottom of a fuel tank 11, with the outside of the hood 9 forming one side wall of the fuel tank, and a surrounding wall 12 forming the other wall of the fuel tank. The hood 9 forms a fan chamber 13, and the gasoline tank forms a surrounding shroud for the fan chamber resulting in a compact arrangement and permitting an attractive exterior appearance, as shown in Fig. 8. Secured to the rear bottom portion of the housing 8 is a casting 14 forming an oil reservoir having a filling opening normally closed by a plug 14', and above the oil reservoir and within the main housing 8 is a crank case housing 15.

The motor has a cylinder 16 provided with external cooling fins 17, and operable within the cylinder is the usual piston operating a connecting rod 18 which in turn operates a crank 19 to cause rotation of the crank shaft 20. The upper

end of the crank shaft is rigidly connected with a starting rope pulley 21 which projects through an opening 22 in the top of the fan chamber 13, and air may be drawn into the fan chamber through open central parts of the pulley 21 as indicated by the arrow in Fig. 2. The upper portion of the crank shaft drives a fan having vanes 23 located within the fan housing, and said portion of the crank shaft may also operate a magneto. Below the crank 19 on the crank shaft is a crank shaft gear 24 driving a timing gear 25, and said timing gear in turn causes rotation of a cam shaft 26 carrying cams 27 and 28 which operate the valves 29 and 30 respectively.

Below the crank shaft gear 24 the crank shaft is surrounded by a shrouded ball bearing assembly 32 located in a bearing pocket 31, and the crank shaft then extends downwardly through a rawhide oil seal assembly 31' mounted in an enlarged recess 32 of a boss which extends upwardly from the bottom of the oil reservoir 14. The crank shaft then depends into the propeller shaft sleeve where it is connected by a coupling member 34 with the propeller shaft 35, the latter being adapted to drive the propeller 36 in the usual manner.

Rotatable with the crank shaft and positioned between the crank shaft gear 24 and the ball bearing assembly 32 (see Fig. 3) is an oil slinger disk 37 which rotates at high speed with the crank shaft and which is adapted to throw surplus oil draining thereon back into the oil reservoir through openings 38 in the reservoir cover plate 39'. What little oil might work its way along beneath the slinger 37 and through the shrouded bearing 32 will be prevented by the rawhide oil seal 31' from leaking into the propeller shaft sleeve 33. However, without the novel use of the slinger in this combination to direct surplus oil during operation back into the oil reservoir, the best packing such as the packing 31 would be ineffective to prevent leakage. The combination of said packing, however, and the slinger in this particular use accomplishes the desired purpose.

The oil reservoir 14 has a surrounding offset extension 39 in the front, 39' in the rear, 40 on one side, and 40' on the other side, with top flange portions 41, 41', 42 and 42' which project inwardly and serve to trap oil and maintain the same in the reservoir. In addition the reservoir has the cover plate 39' which allows communication between the reservoir and crank case only through the openings 38 which are necessary to permit surplus oil from the crank case to flow back into the reservoir. The distance a in Figs. 3 and 6 is such that most of the oil normally in the reservoir 14 can be accommodated in the front extension 39 when the motor is in horizontal position while being carried by the handle 43, or while tilted on the hinge 43' to lift the propeller out of the water. Thus while being carried only a minor amount of oil will flow out of the reservoir through opening 38 and into the crank case 16, and this minor amount will stay in the end 16' of the crank case well below the end 16' of the cylinder so none of said oil will work up into the cylinder to cause fouling of plugs or other trouble (see Fig. 3).

Due to the position of the carrying handle 43, hinge 43', and to the shape of the housing the motor is not, in practice, tilted in the opposite direction to that just described. The motor is, however, frequently placed on either side, particularly while being transported in an automobile, and when so disposed it is important that no oil get into the cylinder 16. With the present construction the distances b and c (Fig. 6) are such that practically all oil can be accommodated in the oil reservoir below the openings 38 when the motor is on its side. What little oil might flow into the crank case through the opening 38 would travel by gravity to a point far below the sides of the cylinder 16, so no harm would result.

As soon as the motor is righted from any of said non-operating positions any oil in the crank case will soon flow back into the reservoir through the openings 38, and when the motor is operated the action of the slinger 37 will assist in returning said oil to the reservoir.

The lower end of the cam shaft 26 has a cam disk 45 mounted thereon and positioned within the oil reservoir. This cam disk operates a piston 46 movable in a cylinder 47, the other end of the cylinder being pivotal on a pin 48 (see Figs. 4 and 5).

It is obvious that when the motor is in operation and when the recess 49 of the cam 45 is in registration with the duct 50 of the piston 46, the piston being moving to withdrawn position in the cylinder 47, a vacuum will be created in the inner end of the cylinder 47 causing oil to be sucked from the reservoir through filter 51, through ducts 52 and 53, through recess 49, into the duct 50 of the piston and into the cylinder. As the cam disk 45 rotates, due to its eccentric relationship with respect to the cam shaft, it will tend to push the piston inwardly into the cylinder and at the same time the peripheral recess 54 will register with the duct 50 of the piston as in Figs. 1, 4 and 5 so that the oil which was previously sucked into the cylinder will be forcibly expelled through the duct 50 into recess 54, through duct 55 in the cam disk 45 and up through longitudinal duct 56 of the cam shaft. The oil under pressure in the duct 56 will be forcibly ejected from apertures 57 (see Fig. 1) onto the bearing 58 between the connecting rod and crank shaft. This oil will then tend to be splashed onto other operating parts. In addition, oil from the upper end of the duct 56 will lubricate the bearing 59 for the upper end of the cam shaft. Due to the fact that all of these bearings which are lubricated are located above the oil reservoir, all surplus oil will drain back into the oil reservoir 14 through the openings 38 assisted by the action of the oil slinger 37.

It is thus apparent that a very effective method of feeding oil is provided wherein the oil is pumped from a lower reservoir and wherein surplus oil is directed back into said reservoir by the novel mechanism and arrangement of parts. It is further apparent that the reservoir is so constructed that peripheral portions have a sufficient capacity to handle a substantial amount of oil in the reservoir when the motor is tipped to horizontal position or laid on its side. It is also apparent that the construction is such that whatever oil does enter the crank case, when the motor is in one of said non-operating positions, will flow to portions of the crank case well below the cylinder so that said oil cannot enter the cylinder and cause trouble.

The fan vanes 23 are adapted to effectively circulate air drawn in through the center of the pulley 21, around the cylinder and other operating parts, to keep the temperature within desired limits.

Exhausted gases from the engine are discharged

through the exhaust pipe 89' below the water level to eliminate noise and objectionable gases.

In view of the above it is apparent that an outboard motor construction has been provided which is compact, light in weight, neat in appearance, and which nevertheless provides for efficient cooling and for lubrication from a separate oil reservoir with a minimum of operating parts, thereby making it practical to use a four cycle engine for outboard motor purposes. The four cycle principle is advantageous over the two cycle arrangement now used in outboard motors because in the latter the oil and gas must be mixed and both stored in a common reservoir. To employ a four cycle principle oil must be in a separate reservoir from the gasoline, and this has heretofore been considered an impractical arrangement in outboard motors because of the various positions in which the motor is disposed during handling and use. Further advantages of the four cycle motor over the two cycle are that in the two cycle construction the presence of lubricating oil in the gasoline effects efficiency, causes fouled plugs and hard starting, and in the two cycle construction it is necessary that each charge of fuel be a full charge whereas in the four cycle construction the amount of a charge can be cut down as desired. This renders the four cycle principle more economical and more flexible as to speed.

It is obvious that features of this invention may be utilized in motors adapted for other than outboard use, and it is also obvious that various changes and modifications may be made without departing from the spirit of invention, and all of such changes are contemplated as may come within the scope of the claims.

What I claim is:

1. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a crank case and with a cylinder rearwardly of said crank case, a reservoir for lubricating oil positioned below said crank case when the motor is in normal operating position, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, the top of the reservoir at the forward end thereof having an inwardly extending flange in sealing connection with the front and side walls of the reservoir forming together with the front, side and bottom walls of the reservoir, a trap in the forward end of the reservoir of a size to accommodate the major portion of oil normally in the entire reservoir whereby said oil is substantially confined in the trap portion of the reservoir upon forward tilting of the motor said trap portion being located remote from the cylinder so that any oil not accommodated in the trap portion will flow into the end of the crank case remote from the cylinder when the motor is in said forwardly tilted position.

2. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a crank case, a reservoir for lubricating oil positioned below said crank case when the motor is in normal operating position, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, the top of the reservoir having a flange extending inwardly from the upper edges of the front and side walls of the reservoir and in sealing connection with said walls to form side and front receptacles each of a size to accommodate the major portion of oil normally in the entire reservoir whereby said oil is substantially confined in one of said receptacle portions of said reservoir upon forward tilting of the motor or when the motor is placed on either side.

3. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a crank case and with a cylinder rearwardly of said crank case, a reservoir for lubricating oil of greater area in plan view than the corresponding area of the crank case positioned below said crank case when the motor is in normal operating position, said increased area of the reservoir including a forward portion which is offset laterally from the front upright wall of the crank case, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, said offset portion of the reservoir having a top cover flange and forming a trap of a size to accommodate the major portion of oil normally in the entire reservoir when the motor is tilted forwardly said trap portion being located remote from the cylinder so that any oil not accommodated in the trap portion will flow into the end of the crank case remote from the cylinder when the motor is in said forwardly tilted position.

4. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a crank case, a reservoir for lubricating oil of greater area in plan view than the corresponding area of the crank case positioned below said crank case when the motor is in normal operating position, said increased area of the reservoir including portions in the front and on each side which are offset laterally from the adjacent upright walls of the crank case, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, said offset portions of the reservoir having top cover flanges and forming traps each of a size to accommodate the major portion of oil normally in the entire reservoir when the motor is tilted forwardly or placed on either side.

5. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a crank case, a reservoir for lubricating oil of greater area in plan view than the corresponding area of the crank case positioned below said crank case when the motor is in normal operating position, said increased area of the reservoir including a portion extending entirely around the reservoir, which is offset laterally from the upright walls of the crank case, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, said offset portions of the reservoir having top cover flanges and forming traps for accommodating the major portion of the oil normally in the entire reservoir when the motor is tilted up to approximately 90° in any direction away from normal operating position.

6. In an outboard motor having a support and having means whereby the motor may be pivoted forwardly on said support to an inoperative position, a combustion engine provided with a cylin-

P-344

der in the rear portion of the motor and having a crank case in the forward portion, a reservoir for lubricating oil positioned below the crank case when the motor is in normal operating position, there being a drain opening between said crank case and reservoir, means for feeding oil from said reservoir to parts in the crank case to be lubricated, said reservoir having a portion offset forwardly from the front of the crank case forming a trap of a size to accommodate the major portion of oil normally in the entire reservoir when the motor is tilted forwardly, any oil in the crank case being accommodated in the end thereof remote from the cylinder.

7. In an outboard motor or the like having a combustion engine provided with a crank case and having a crank shaft which is substantially vertically disposed in said crank case when the motor is in normal operating position, a bearing within which the lower end of the crank shaft is journaled, a reservoir for lubricating oil surrounding the lower end of the crank shaft, there being a drain opening in the bottom of the crank case communicating directly with said reservoir through which surplus oil may drain back into said reservoir, means in the reservoir through which the crank shaft extends for sealing all portions of the crank case from the oil reservoir and from oil which flows through said drain opening in the bottom of the crank case, means in the bottom of the crank case rotatable with said crank shaft above and adjacent to said bearing for centrifugally throwing surplus oil which drains thereon from the crank case into said opening and directly back into said reservoir, and means for feeding oil from said reservoir to parts in said crank case to be lubricated.

8. In an outboard motor or the like having a combustion engine provided with a crank case and having a crank shaft and a cam shaft which are substantially vertically disposed in said crank case when the motor is in normal operating position, a reservoir for lubricating oil surrounding the lower end of the crank shaft and positioned below the crank case, an eccentric on said cam shaft positioned in said reservoir, there being a drain opening between the top of said reservoir and said crank case through which surplus oil may drain back into said reservoir, an oil pump cylinder mounted for pivotal movement in said reservoir, a tubular piston movable in said cylinder and having a projecting end with a circular opening within which the cam shaft eccentric fits so that the pump is operated by rotation of said cam shaft, said cam shaft having a longitudinal oil duct therein within a discharge outlet in the crank case, said eccentric of the cam shaft having a port communicating with the longitudinal oil duct of the cam shaft and adapted to communicate with the interior of the tubular piston in certain positions of operation.

9. In an outboard motor or the like having a combustion engine provided with a crank case and having a crank shaft which is substantially vertically disposed in said crank case when the motor is in normal operating position, a reservoir for lubricating oil surrounding the lower end of the crank shaft and positioned below the crank case, there being a drain opening in the bottom of the crank case communicating directly with said reservoir through which surplus oil may drain back into said reservoir, a ball bearing assembly around the lower end of the crank shaft and above the reservoir, means connected to the bottom of the crank case for holding said bearing assembly in position, an oil seal engageable around said crank shaft below said bearing, a tubular boss extending upwardly from the bottom of the reservoir through which the crank shaft extends and within which the oil seal is positioned, said boss preventing escape of oil from the reservoir, and said boss and bearing holding means sealing all portions of the crank shaft below the bottom of the crank case from oil which has drained into the drain opening in the bottom of the crank case, means in the bottom of the crank case rotatable with said crank shaft above and adjacent to said bearing for centrifugally throwing surplus oil which drains thereon from the crank case into said opening and back into said reservoir, and means for feeding oil from said reservoir to parts in said crank case to be lubricated.

10. In an outboard motor or the like having a combustion engine provided with a crank case and having a crank shaft which is substantially vertically disposed in said crank case when the motor is in normal operating position, said crank case having a bottom formed with a depending tubular portion forming a bearing pocket through which the crank shaft extends, means forming a reservoir for lubricating oil surrounding the lower end of said crank shaft, said reservoir having its bottom formed with an upstanding tubular boss which engages the lower end of the bearing pocket and through which the crank shaft extends, there being a drain opening in the bottom of the crank case located radially outwardly from said bearing pocket and communicating with the reservoir, all portions of the crank shaft below the bottom of the crank case being sealed by said depending tubular portion and upstanding tubular boss from oil draining downwardly through said opening, the top of the reservoir at the forward end thereof having an inwardly extending flange in sealing connection with the front and side walls of the reservoir forming a trap in the forward end of the reservoir of a size to accommodate the major portion of oil normally in the entire reservoir whereby said oil is substantially confined in said trap portion upon forward tilting of the motor.

11. In an outboard motor or the like having a combustion engine provided with a crank case and having a crank shaft which is substantially vertically disposed in said crank case, when the motor is in normal operating position, said crank case having a bottom through which the lower end of the crank shaft extends, a reservoir for lubricating oil positioned below said crank case bottom when the motor is in normal operating position and surrounding said lower end of the crank shaft, there being a drain opening in the bottom of the crank case communicating with said reservoir, means rotatable with the crank shaft and located in the crank case adjacent the bottom thereof for centrifugally throwing surplus oil which drains thereon to said opening, means for sealing all portions of the crank shaft below the bottom of the crank case from oil draining downwardly through said opening, the top of the reservoir at the forward end thereof having an inwardly extending flange in sealing connection with the front and side walls of the reservoir forming a trap in the forward end of the reservoir of a size to accommodate the major portion of oil normally in the entire reservoir whereby said oil is substantially confined in said trap portion upon forward tilting of the motor.

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Sept. 12, 1944. J. B. FARR 2,357,942

OUTBOARD MOTOR

Filed Feb. 10, 1940 2 Sheets-Sheet 1

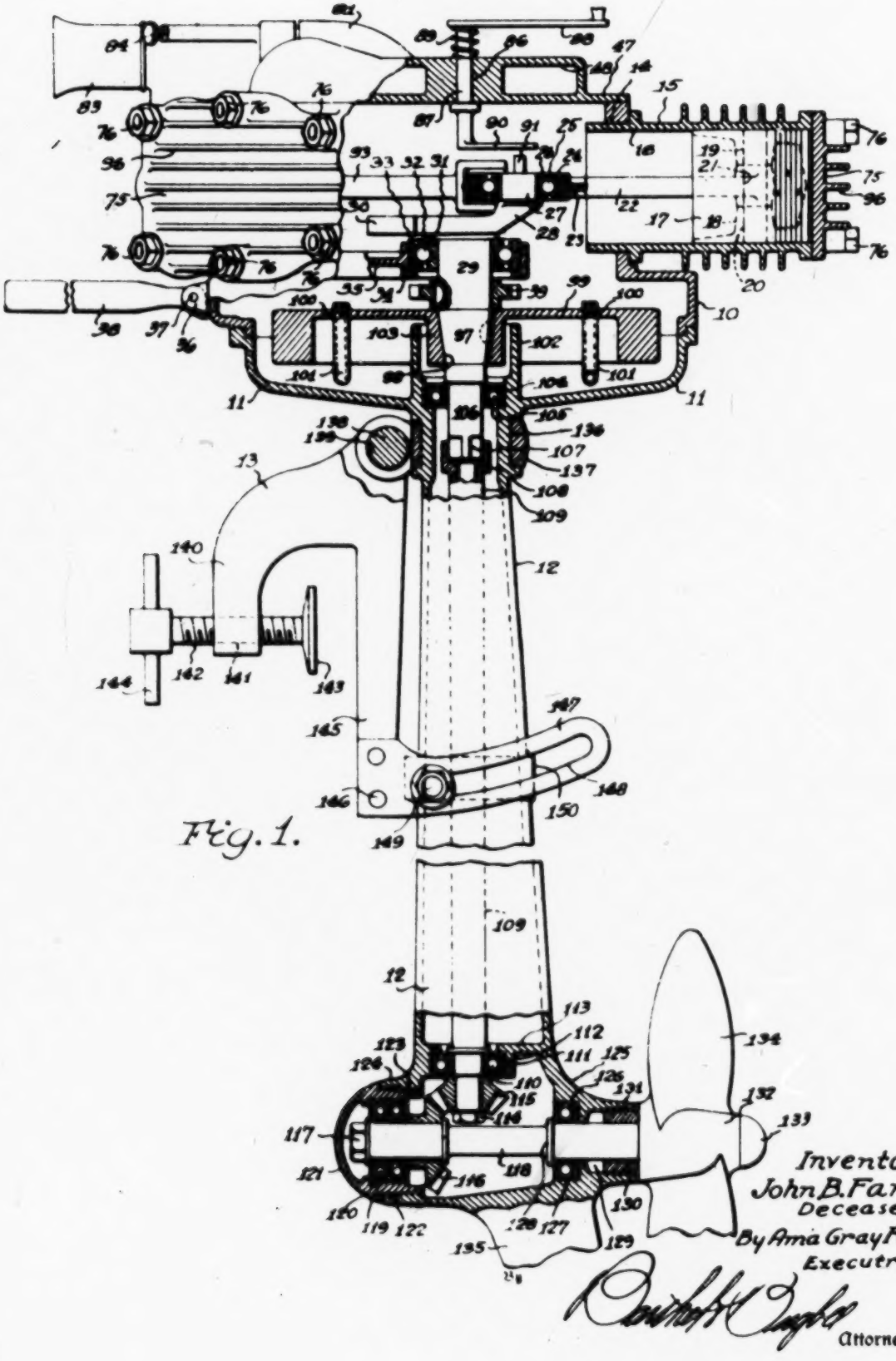

Fig. 1.

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Sept. 12, 1944. J. B. FARR 2,357,942

OUTBOARD MOTOR

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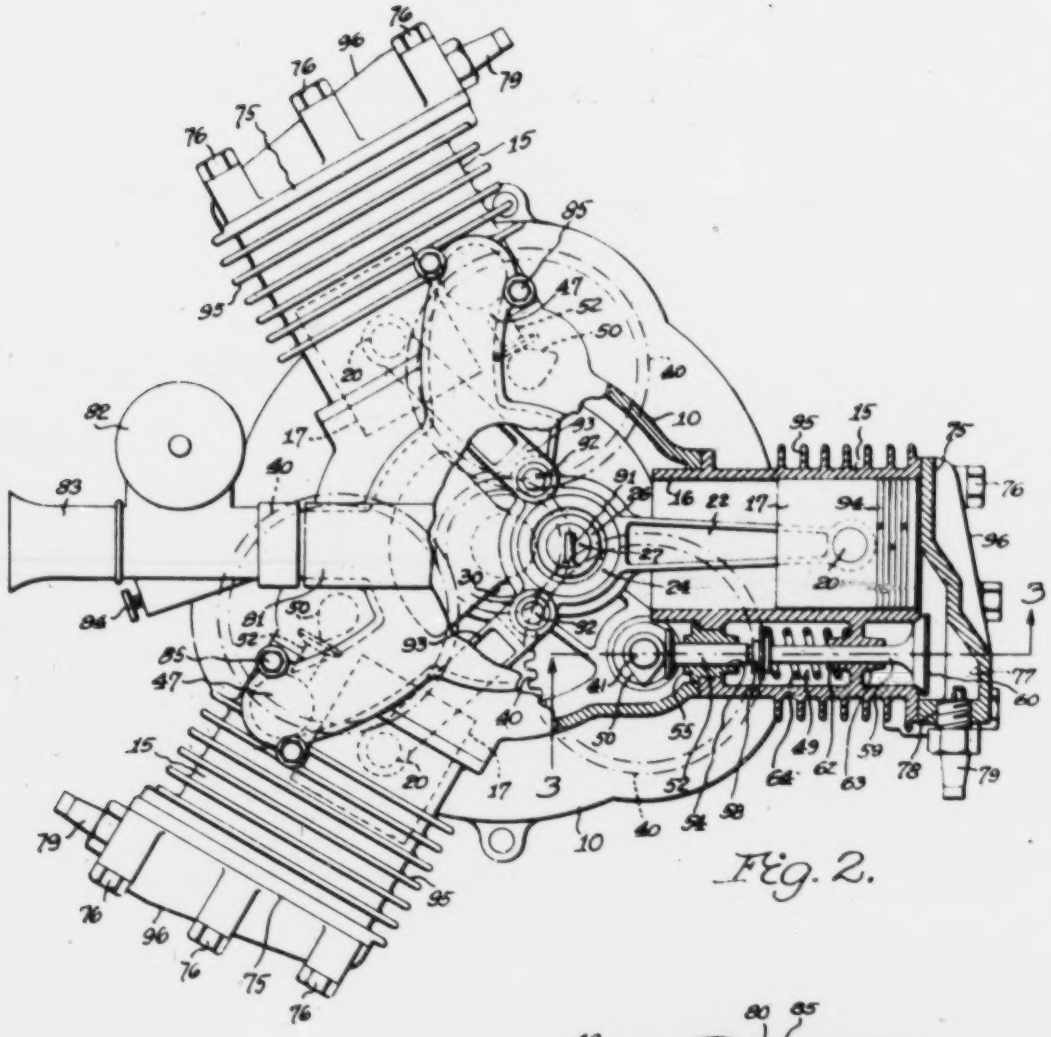
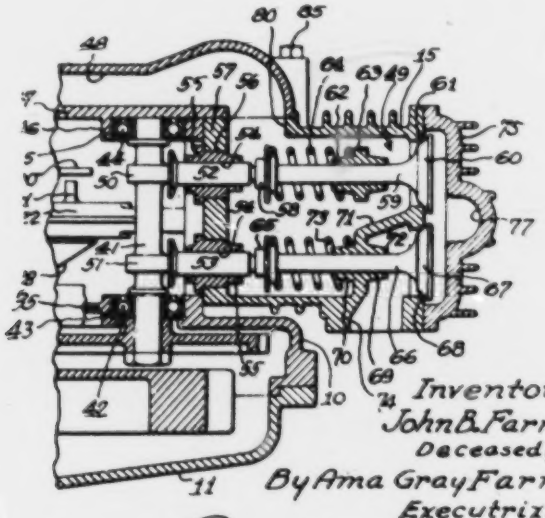


Fig. 2.



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Patented Sept. 12, 1944 2,357,942

UNITED STATES PATENT OFFICE

2,357,942

OUTBOARD MOTOR

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Application February 10, 1940, Serial No. 318,215

3 Claims. (Cl. 123—195)

This invention relates to internal combustion motors and in particular to outboard motors for propelling boats.

One object of this invention is to provide a multiple radial cylinder outboard motor with at least three cylinders wherein the various pistons are secured to a common crank through their connecting rods, this crank being mounted upon a crank shaft which drives the propeller.

Another object is to provide a four cycle radial multiple cylinder outboard motor with at least three cylinders wherein each cylinder is provided with a cam shaft for actuating the intake and exhaust valves, each cam shaft being preferably driven from a common gear on the crank shaft.

Another object is to provide a multiple radial cylinder outboard motor wherein the various piston connecting rods are connected to a half crank mounted on the crank shaft.

Another object is to provide a multiple radial cylinder outboard motor with at least three cylinders having a crank shaft with a half crank carrying an anti-friction bearing to which the various piston connecting rods are connected, so that the bearing, such as a ball bearing, may be mounted on the half crank without being split or otherwise divided.

Another object is to provide a multiple radial cylinder outboard motor with at least three cylinders having the multiple connecting rods connected to a half crank on the crank shaft, the end of this half crank projecting so as to be engaged by a hand operated crank for starting purposes.

Another object is to provide a multiple radial cylinder outboard motor having a vertical crank shaft driven by connecting rods from the multiple cylinders, the crank shaft carrying a fly-wheel beneath the cylinders, this fly-wheel rotating in a horizontal plane and carrying scoop devices which scoop up the oil and throw it upward to various parts of the motor.

Another object is to provide a multiple radial cylinder outboard motor with at least three cylinders having a cover plate on top of the housing, this cover plate having intake manifolds therein for equally distributing the explosive gas mixture to the various intake valves.

Another object is to provide a multiple radial cylinder outboard motor having the intake valve chamber immediately adjacent the exhaust valve chamber and separated therefrom by a thin wall so that the cold incoming gases tend to cool the walls heated by the outgoing exhaust gases.

Another object is to provide a multiple radial cylinder outboard motor having a one piece tubular propeller shaft housing having bearing seats at its opposite ends so that these bearing seats may be machined in accurate alignment without the danger of subsequent misalignment in assembly.

In the drawings:

Fig. 1 is a side elevation, partly broken away in central vertical section, showing a preferred embodiment of the multiple radial cylinder outboard motor according to the invention;

Fig. 2 is a top plan view, partly broken away, of the outboard motor shown in Fig. 1; and

Fig. 3 is a vertical section through the valve structure of a cylinder, taken along the line 3—3 in Fig. 2.

General arrangement

In general, the outboard motor of this invention consists of an approximately circular crank case carrying three or more radial cylinders having pistons connected to an anti-friction bearing mounted upon a half crank, which, in turn, is a part of the vertical crank shaft. This crank shaft, beneath the cylinders, carries a horizontal fly-wheel having scoop elements arranged to scoop up the oil from the crank case or sump and throw it to various parts of the invention. The crank shaft also carries a timing gear which meshes with individual timing gears mounted on an individual cam shaft for each of the several cylinders, this cam shaft operating the intake and exhaust valves of each cylinder. The half crank shaft projects upward so that it is engageable by a hand crank mechanism for starting purposes.

The upper part of the motor above the cylinders is occupied by a cover plate having intake manifolds therein running to the intake valves of the various cylinders. By this means the explosive gas is equally distributed to the various cylinders from the carburetor. Each intake manifold runs to an intake valve chamber which is separated by a thin wall from the exhaust valve chamber so that the cold incoming gases will cool the exhaust valve chamber.

The crank shaft is coupled to a propeller shaft mounted in anti-friction bearings in a one piece tubular housing, the bearing seats of which are machined in accurate alignment. Since the housing is not divisible in manufacture or assembly, this construction insures accurate alignment of the bearings.

The drive housing is mounted in a suitable bracket mechanism attached to the boat by which

the motor may be turned bodily through a complete revolution so that the boat may be reversed or the rudder, attached to the lower portion of the housing, turned through a wide angle.

Detailed construction

Referring to the drawings in detail, Fig. 1 shows a preferred embodiment of the outboard motor of this invention as consisting of a crank case 10 mounted upon the sump portion 11 of the drive housing 12, which, in turn, is pivotally supported upon the bracket 13 by means subsequently to be described.

The crank case 10 is provided with a plurality of radially disposed apertures 14 within which are mounted cylinders 15 having cylinder bores 16 containing pistons 17. The pistons 17 are provided with internal bosses 18 having aligned bores 19 carrying the wrist pins 20.

The wrist pins 20 are engaged by the bores 21 in the end of the connecting rod 22, the opposite end of which is provided with a bore 23 surrounding and containing the outer element 24 of an anti-friction bearing 25. The inner element 26 of the latter is mounted upon the portion 27 of the half crank 28 forming a part of the crank shaft 29. The half crank 28 is provided with an oppositely projecting counterweight portion 30 for counterbalancing the thrust of the crank.

The crank shaft 29 carries the inner element 31 of an anti-friction bearing 32, the outer element 33 of which is supported in a recess 34 within the spider 35 forming a part of the crank case 10. The latter is provided with an integral yoke portion 36 carrying a pivot pin 37 upon which is mounted a pivot handle 38 by which the motor may be swung to and fro by the operator around a vertical axis, for steering or reversing purposes.

Keyed to the crank shaft 29 is a timing gear 39 which meshes with gears 40 (Figs. 2 and 3) mounted on the cam shafts 41. Each cylinder 15 is provided with its own individual cam shaft, the lower end of which is mounted in the anti-friction bearings 42 supported in recesses 43 in the spider 35 of the crank case 10 (Fig. 3). The upper end of each cam shaft is mounted in anti-friction bearings 44 supported in the recess 45 formed in the boss 46. The bosses 46 project downwardly from the cover plate 47, the latter also containing intake manifold passageways 48 leading to the intake valve chambers 49 in each cylinder 15. The cam shafts 41 are provided with intake and exhaust valve cams 50 and 51, respectively, serving to actuate the valve tappets 52 and 53, respectively, mounted in the bores 54 of the collars 55. The latter, in turn, are mounted in the bores 56 within the partition portions 57 forming a part of the cylinder 15 (Fig. 3). The valve tappets 52, actuated by the cams 50, engage the enlargements 58 upon the ends of the intake valves 59 having valve heads 60 engaging valve seats 61 in the cylinders 15. The intake valve 59 is reciprocably mounted in a bore 62 within the spider 63 extending across the intake chamber 49. A coil spring 64 urges the intake valve 59 toward its closed position.

The valve tappet 53 engages an enlargement 65 upon the end of the exhaust valve 66 having a head 67 engaging exhaust valve seat 68. The exhaust valve 66 is reciprocably mounted in a bore 69 within a boss 70 forming a part of the partition wall 71 between the intake chamber 49 and the exhaust chamber 72 (Fig. 3). The exhaust chamber 66 is simply provided with a coil spring 73 urging it into a closed position. The exhaust valve chamber 72 is provided with an exhaust port 74 to which an exhaust manifold (not shown) may be connected in any conventional way, and leading either to a conventional muffler or to an underwater exhaust. These elements are omitted to simplify the disclosure.

The cylinder bores 16 of the cylinders 15, at their outer ends, are closed by the cylinder heads 76 bolted thereto as at 76 and containing the ignition chambers 77 having threaded bores 78 containing the spark plug 79. The energization of the spark plugs 79 is effected by electricity supplied from a conventional spark coil or magneto (not shown) through a conventional timer and distributer (not shown) mounted on the upper end of one of the cam shafts 41. This timing and distributing mechanism is likewise omitted for purposes of simplifying the showing.

Each of the intake chambers 49 is provided with an intake port 80 from which the intake manifold passageways 48 lead to the carbureter connecting portion 81 to which is attached the carbureter 82. The latter is provided as usual with an air intake portion 83 and an adjusting screw 84 for adjusting the needle valve.

The cover plate 47 containing the exhaust passageways 48 is bolted as at 85 to the cylinders 15. The cover plate 47 is likewise provided with a vertical bore 86 containing the shaft 87 on one end of which is mounted the manually operated starting crank 88. A coil spring 89 urges the shaft 87 and crank 88 upward. The other end of the shaft 87 carries an arm 90 engageable with a projection 91 upon the crank portion 27. The projection 91 is wedge-shaped (Fig. 2) so as to permit the arm 90 to be thus disengaged automatically when the motor starts.

Connecting rod 22 is a master connecting rod which is provided with pivot pins 92 to which the connecting links or secondary connecting rods 93 are pivotally connected. Opposite ends of the secondary connecting rods 93 are pivotally connected to the wrist pins 20 of the pistons 17 in the manner previously described. The pistons 17 are provided with the usual piston rings 94 for the prevention of leakage between the pistons 17 and the cylinder bore 16. The cylinders 15 are provided with the usual cooling fins or flanges 95 with corresponding fins 96 upon the cylinder heads 76.

The crank shaft 29 is provided with a tapered portion 97 engaged by the correspondingly tapered bore 98 of the fly-wheel 99 keyed thereto. The fly-wheel 99 is provided with bores 100 within which are secured the downwardly extending scoop tubes 101. The latter project slightly above the top of the fly-wheel 99 and, in the rotation of the latter, serve to pick up oil from the sump portion 11 and throw it upward to the various moving parts of the motor.

The sump portion 11 is provided with an upwardly projecting annular flange 102 surrounding the fly-wheel hub 103 and serving to prevent the escape of lubricant. The sump portion 11 within the flanged portion 102 is provided with a recess 104 serving to receive the outer element of an anti-friction bearing 105, the inner element of which is mounted upon the reduced diameter portion 106 of the crank shaft 29.

The crank shaft portion 106 terminates in a

coupling portion 107 having cooperating ridges engaging a corresponding coupling socket 108 in the upper end of the drive shaft 109. The latter is preferably tubular and at its lower end carries the inner element of an anti-friction bearing 110, the outer element of which is supported in a recess 111 in the boss 112 forming a part of the partition 113 in the lower end of the drive housing 12 (Fig. 1).

Secured, as at 114, to the lower end of the drive shaft 109 is a bevel gear 115 meshing with a bevel gear 116 secured, as at 117, to the propeller shaft 118. One end of the propeller shaft 118 is mounted in double anti-friction bearings 119 supported in a recess 120 formed in the drive housing cap 121. The latter is threaded, as at 122, into the bore 123 in the projecting portion 124 at the lower end of the drive housing 12.

The drive housing 12 also is provided with a projecting portion 125 (Fig. 1) provided with a recess 126 containing an anti-friction thrust bearing 127 which is engaged by the enlargement 128 on the propeller shaft 118. The latter is provided with a packing 129 compressed by a gland 130 threaded into the bore 131. The outer end of the propeller shaft 118 is provided with a screw propeller 132 secured thereto, as at 133, and having propeller blades 134. Formed integrally with the drive housing 12 is a downwardly projecting fin or rudder 135.

The upper end of the drive housing 12 is provided with an annular recess 136 loosely receiving an annular member 137 carrying a pivot pin 138. Engaging the pivot pin 138 is the bore 139 formed in the upper end of the bracket 13 which has an outwardly extending arm structure 140 provided with threaded bores 141 carrying a pair of clamping screws 142, each being provided with a head 143 and handle 144 for clamping the motor to a boat (in Fig. 1 the two clamping screws 142 are in horizontal alignment and hence only one is visible.)

The bracket 13 is likewise provided with a downwardly extending arm structure 145 to which are secured, as at 146, spaced arms 147 containing arcuate slots 148 having their centers of curvature at the center of the pivot shaft 138. The slots 148 are engaged by adjusting bolts 149 seated in annular members 150 loosely mounted upon the casing 12 in a manner similar to the annular membr 137. In this manner the motor may be swung completely around by grasping the handle 38. The bolts 149 also permit an adjustment of the motor and a tilting relatively to the vertical plane.

The drive housing 12 is preferably of streamlined cross-section so as to offer the minimum resistance in its passage through the water. For this purpose, the leading edge is rounded and the trailing edge is thin and fin-shaped.

Operation

The operation of the invention has been described, in part, in connection with the description of the construction thereof. The operator starts the engine by rotating the hand crank 90 after pushing it downward into engagement with the projection 91 on the half crank 26. Assuming that the carbureter 82 has been supplied with fuel and the timing apparatus and spark plugs 79 energized from a suitable source of electricity, the explosions take place in timed sequences within the cylinders 15.

While the explosions are taking place within the cylinders 15, the cam shafts 41 are being rotated so as to open and close the intake valves 66 and exhaust valves 67 in accordance with the predetermined cycle of operation, according to the four-cycle plan. Thus the piston 17 makes one complete stroke upon its explosion and exhaust half strokes and a successive complete stroke upon its intake and compression half strokes. This cycle of operations is repeated indefinitely according to the desires of the operator.

As the explosion stroke of each cylinder occurs, the thrust of each piston 17 is communicated to the half crank 26 of the crank shaft 28 by the engagement of the main connecting links 93 with the anti-friction bearing 29. This rotation is transmitted to the drive shaft 109 through the coupling members 107 and 108 and, thence, to the screw propeller 132 through the shaft 118 and bevel gearing 115 and 116.

Meanwhile, the rotation of the fly-wheel 99 causes the scoop tubes 101 to pick up oil from the sump portion 11 and throw this oil upward to lubricate the various bearings and the cylinder bores 16.

The exhaust valve chamber 72 is cooled by the incoming gas passing through the intake chamber 69. This occurs by reason of the contact of the cool incoming gas with the thin partition 71 between the two chambers.

The motor may be adjusted as to position by manipulating the bolts 149, thereby allowing for any tilt at which the bracket structure 13 must be set in the particular boat.

To steer the boat, the operator merely swings the handle 39, thereby swinging the motor and its connected parts, including the drive housing 12, screw propeller 132, and the rudder 135. To reverse the boat, the operator merely swings the handle 39 through a half revolution, so that the screw propeller 132 is directed forward instead of rearward, as shown in Fig. 1. The bearing ring members 137 and 150 permit this wide angle swinging of the motor assembly relatively to the bracket structure 13.

The term "outboard motor" used herein is defined as a small internal combustion engine with propeller attached, temporarily secured to the stern of a small boat.

While a specific embodiment of the invention has been described and illustrated, it will be understood that various modifications may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. In an outboard motor, a crank case having a closure plate to provide an end wall therefor, a plurality of removable cylinders disposed radially about said crank case, pistons reciprocably mounted in said cylinders, a crank-shaft journaled in one wall of said case, a cantilever crank pin on the crank shaft having its end terminating within the confines of the cylinders and spaced from the end wall closure plate a sufficient distance to provide clearance therebetween, and a connecting rod assembly mounted said crank pin being drivingly connected to said piston, said clearance space being so proportioned as to admit the removal of the connecting rod assembly laterally from the crank pin after the cylinders have been removed from the crank case.

2. In an outboard motor, a crank case having an open end provided with a closure plate, a plurality of removable cylinders disposed about the

May 8, 1945. W. G. WINKELS ET AL 2,375,718

CRANKCASE AIR-PRESSURE CONTROL MEANS

Filed April 23, 1943

FIG. 1.

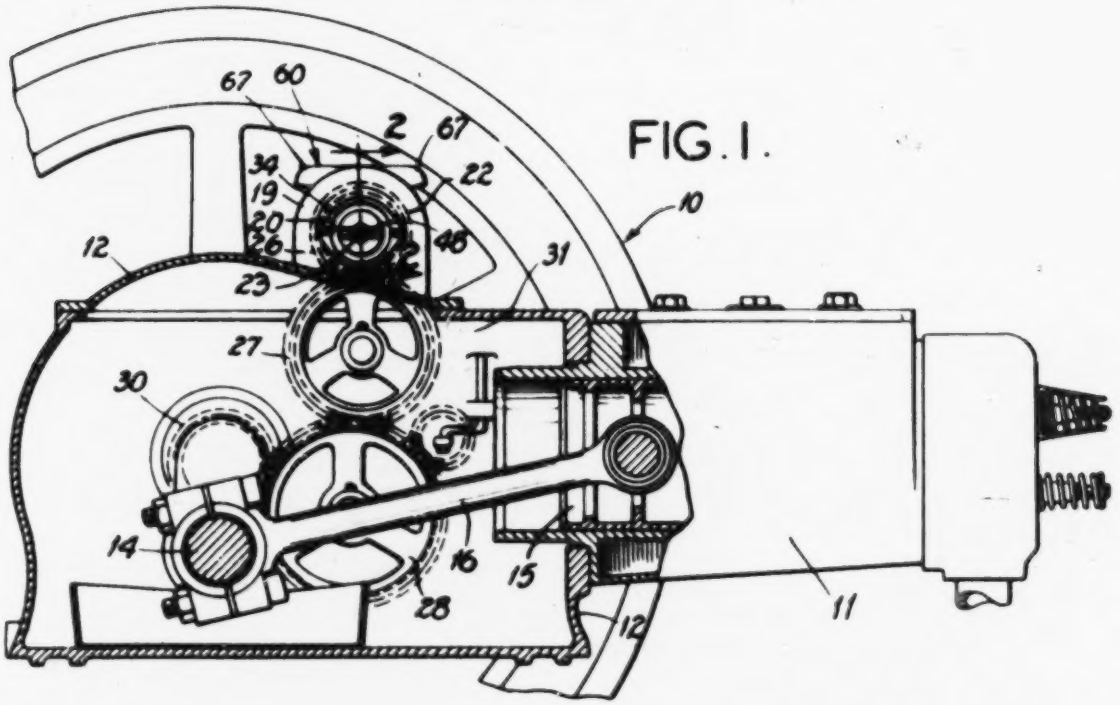
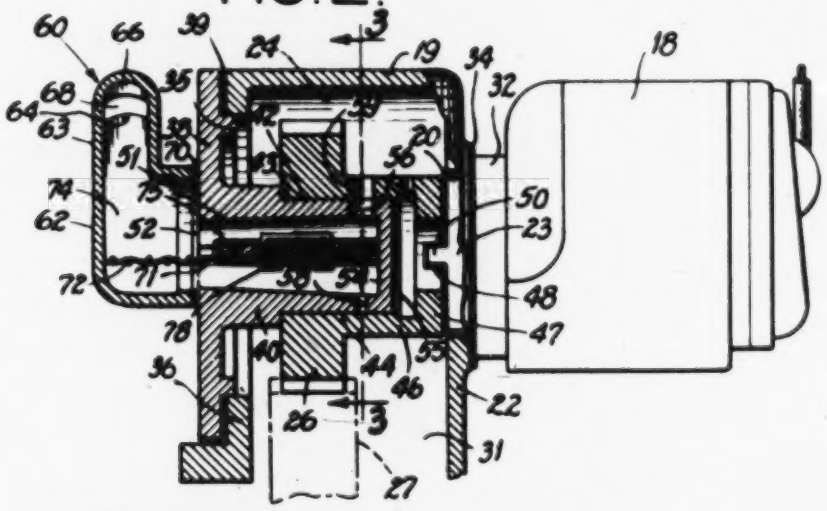


FIG. 2.



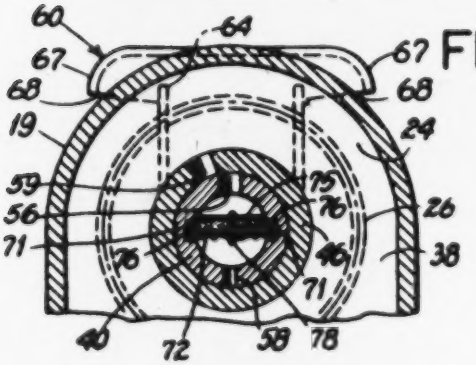


FIG. 3.

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P-352

crank case and extending radially therefrom, pistons mounted in said cylinder, a crank shaft journaled in said crank case, a cantilever crank pin on said crank shaft having its end terminating within the confines of the cylinders and spaced from the closure plate a sufficient distance to provide a clearance space therebetween, and a connecting rod assembly mounted on said crank pin connecting said pistons with said crank pin, said clearance space being so proportioned as to permit removal of the connecting rod assembly laterally from the crank pin after the cylinders have been removed from the crank case.

3. In an outboard motor, a crank case having an end wall, a series of cylinders radially disposed about said crank case, pistons reciprocably mounted in said cylinders, a crank-shaft journaled in said crank case, a cantilever crank pin on said crank shaft within the confines of said cylinders with its end terminating a sufficient distance from the end wall to provide a clearance space, and a connecting rod assembly mounted on said crank pin comprising a main connecting rod connected to one of the pistons, and a plurality of secondary connecting rods connecting the remaining pistons to said main connecting rod, said clearance space being so proportioned to admit removal of the connecting rod assembly laterally from the crank pin after the cylinders have been removed from the crank case.

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UNITED STATES PATENT OFFICE

2,388,994

CENTRIFUGAL SPARK CONTROL MECHANISM FOR FLYWHEEL MAGNETOS

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Application August 11, 1944, Serial No. 549,091

3 Claims. (Cl. 64—25)

This invention relates to an automatic spark advance mechanism for flywheel magnetos.

The problem of providing in a flywheel magneto for the automatic control of the spark in response to variations in engine speed, is difficult because of the lack of space within the flywheel and, particularly is this so in the very small flywheels, which are now frequently used and are only a few inches in diameter. The small space within these small flywheels is so crowded with magneto parts that there is no room left for governor weights of any substantial size nor is there room for such weights to swing.

This invention has been devised to provide, in a flywheel magneto of an automatic spark control mechanism, in which the governor weights or weights are located outside the flywheel, where they may be as large as is necessary to get effective action and where there is ample room for these weights to swing, and in which the part within the flywheel occupies so small a space as to be for all practical purposes negligible.

This invention will be disclosed with reference to the accompanying drawings, in which

Fig. 1 is an end elevational view of a flywheel magneto embodying the invention;

Fig. 2 is a sectional view, looking in the same direction as Fig. 1 and showing the magneto elements housed within the flywheel, the spark timing mechanism being shown in retarded position;

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 2; and

Fig. 4 is a fragmentary sectional view taken similarly to Fig. 2 but showing the spark timing mechanism in advanced position.

Referring to these drawings, the spark timing mechanism of this invention includes a governor weight 1 (Fig. 1) fixed to the outer end of a small shaft 2, which is rotatably mounted in the hub of a flywheel 3 (Fig. 3) and is located parallel with the axis of the flywheel. A spring 4 (Fig. 1) interconnects an outer corner of weight 1 to any suitable fixed point in the end wall of the flywheel, as shown, to one of a series of fan blades 5 formed on said wall. The spring 4 tends to hold weight in the position illustrated by full lines in Fig. 1 in which position the weight abuts a limit stop 6 fixed in said wall of the flywheel. Another and similarly fixed limit stop 7 is adapted to be engaged by the weight 1, when it is swung outwardly by centrifugal force, to limit the outward movement of the weight to the position shown by dotted lines in Fig. 1. The inner end of shaft 2 (Fig. 3) is formed with an integral crank 8, the crankpin portion of which is engaged in a longitudinally directed slot 9 in the breaker-point cam of the magneto. As the governor weight 4 moves from the full line position to the dotted line position of Fig. 1, the breaker point cam is moved from the full retard position shown in Fig. 2 to the full advance position shown in Fig. 4

The invention has been shown, by way of illustrative example, in connection with a flywheel magneto of the type disclosed in the Harmon Patent No. 2,101,392, granted December 7, 1937. This magneto will be briefly described herein, reference being had to said patent for a full disclosure if such is necessary or desired. In the following description, the reference numerals indicate the same parts as in the patent.

The field structure is fastened in the rim portion 10 of the flywheel and consists of a permanent magnet 11 and laminated pole shoes 12. The stator comprises a laminated structure having three legs 13, 14, and 15, integrally united at their inner ends and having their outer ends shaped to cooperate with the surfaces 16 of pole shoes 12 during rotation of the rotor. Primary and secondary coils 17 and 18 are mounted on the leg 14. The relatively fixed and movable breaker points are respectively shown at 19 and 20. The point 19 is fixed to and insulated from a bracket 21. The point 20 is fixed to one end of a breaker lever 22, pivoted at 23 and having its other end riding on the periphery of a breaker cam 24. This cam, unlike the cam of the patent, is free to turn on the engine crankshaft 25, being relatively moved as, and to the extent, above described. The flywheel 1 is fixed to the crankshaft 25. The breaker lever 22 has a spring 26 urging it towards cam 24 and the latter has a low surface 27 which allows the breakers 19 and 20 to close, the remainder of the cam being such as to hold the breaker points open. The condenser is shown at 28 and 29 is the electrical connection from the ungrounded terminal of the primary coil to the insulated terminals of the condenser 28 and to the insulated breaker point 19. 30 is the high tension wire leading from the ungrounded terminal of the secondary coil. The core structure is fixed by cap screws 31 to a stator plate 32, which in turn is fixed by screws 33 to a part 34 of the engine crankshaft.

The operation of the magneto is the same as that of the patent except that the governor arrangement, first above described, affords an automatic spark advance. The magneto is

Nov. 13, 1945. R. E. PHELON 2,388,994

CENTRIFUGAL SPARK CONTROL MECHANISM FOR FLYWHEEL MAGNETOS

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Fig. 2.

Fig. 4.

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CENTRIFUGAL SPARK CONTROL MECHANISM FOR FLYWHEEL MAGNETOS

Filed Aug. 11, 1944 2 Sheets-Sheet 1

Fig. 1.

Fig. 3.

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chambered outlet attachment in registry with the open end of said chamber, an engine controlled valve on said member, adapted for opening one of said ports to the crankcase interior in the period of piston developed pressure in the crankcase, for permitting discharge of lubricant laden crankcase air through said chamber and said chambered outlet attachment, and means including the chambered outlet attachment, effective for condensing and collecting lubricant from the crankcase air discharged through said chamber and attachment, said valve being effective in the period of crankcase suction, to open the other of said ports for the suction return to the crankcase of lubricant collected by said means.

8. The combination with an internal combustion engine providing an engine driven gear in the crankcase for operating a device adjunctive to the engine organization, of a crankcase air-pressure control device comprising a member extending within the crankcase and providing a bearing support for said gear and hub extension, said member providing a chamber therein open to the atmosphere and spaced ports for communication with the crankcase interior, said gear being adapted as a control valve for said ports, operable for opening one of said ports to the crankcase interior in each period of piston developed pressure in the crankcase, and for opening another of the ports thereto in each period of piston developed suction in the crankcase.

9. The combination with an internal combustion engine providing an engine driven gear in the crankcase having a hub extension for driving connection with a device adjunctive to the engine organization, of a crankcase air-pressure control device comprising a member extending within the crankcase and providing a bearing support for said gear and hub extension, said member providing a chamber therein open to the atmosphere at its outer end, and having spaced ports near the inner end of the chamber, underlying the hub extension of said gear, and said gear hub extension having an opening therein registrable with said ports during gear rotation, provided for opening said ports to the crankcase interior in each cycle of piston developed pressure and suction in the crankcase, such that one of said ports is opened thereby in the period of piston developed pressure and another port opened in the period of piston developed suction.

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the foregoing description of operation, it
pear now that the control device in its
to relieve crankcase compression in the
sion cycle of engine piston operation and
nt suction return of air to the crankcase
cycle of piston suction effect in the crank-
vords a fully effective means for control-
pheric air pressure, to the extent that
ns existence of above-atmospheric pres-
ction and facilitates maintenance of sub-
ssure or even a slight negative pressure
vacuum in the crankcase during at least
ater portion of each complete cycle of en-
tion operation. As a consequence of the
spheric pressures or slight vacuum thus
ed in the crankcase, the crankcase lubri-
fluid is most effectively retained therein
leakage or loss to the crankcase exterior,
uch cylinder ports, crankcase joints and
ch operating parts of the engine which
through wall portions of the crankcase
sulting suction retention of lubricating
the crankcase together with the return
of fluid condensed and otherwise re-
from the crankcase air vented to atmos-
through the present novel control device
ly conserves the crankcase lubricating
an important device as will be now fully
ated.

present crankcase air-pressure control de-
ly attains the objects herein expressed,
ditionally presents a relatively compact
sm having but few parts and wherein
rating valve element thereof is embodied
ferrous, in the engine driven magneto
ver of the engine assembly illustrated
h the device is shown herein as applied
ption of the crankcase for con-
in the illustrated drive cover
the engine magneto located externally
the crankcase it will be understood that
ice may be readily located in any other
f the crankcase with appropriate relocа-
the engine shaft drive connection to the
port-control element 25 of the device
e the present disclosure relates to a single
ed embodiment of the invention, it will be
tood that alterations or modifications
may be made without departing from the
and intended scope of the invention as de-
by the appended claims.

claim:

control device of the character described
ubstantially closed crankcase comprising
providing a chamber open to the atmos-
means including a valve for establishing
pheric communication with the crankcase
said chamber at least once in each cy-
developed pressure and suction in the
case, and means controlled by the valve
tablishing in the suction period of said
communication between said chamber and
rankcase.

control device of the character described
ubstantially closed crankcase comprising
ber having a chamber therein open to the
sphere and provided with spaced ports for
unication with the crankcase interior, and
means operatively supported by said mem-
mbered for opening said ports to the crank-
nterior in each cycle of developed pressure
uction in the crankcase, such that one of
orts is thereby opened in each period of
ped pressure and the other port opened
in each period of developed suction in the crank-
case.

3. A control device of the character described
for a substantially closed crankcase, comprising
a member extending within the engine crankcase
and provided with a chamber therein open to the
atmosphere, said member having spaced ports
communicating with said chamber, valve means
in control of said ports and operable for succes-
sively opening the ports to the crankcase interi-
ior and valve actuating means for operating said
valve means in timed relation to the cycle of
developed pressure and suction in the crankcase
the operation of said valve means thereby serv-
ing to open one of said ports in the periods of
piston developed pressure and the other port in
the periods of piston developed suction in the
crankcase.

4. A crankcase air-pressure control device for
internal combustion engines, comprising a mem-
ber extended within the engine crankcase and
provided with a chamber therein open to the at
mosphere said member having spaced ports com-
municating with said chamber, an element ro-
tatable on said member in a position to overlie
said ports and having air opening therein lo-
cated for registry with said ports said element
during rotation serving through said opening
therein to open said ports to the crankcase in-
terior and engine controlled means for oper-
ating said element in timed relation to the cy-
cle of piston developed pressure and suction in
the crankcase, the operation of said element
thereby serving to open one of said ports in the
periods of piston developed pressure and the
other port in the period of piston developed suc-
tion in the crankcase.

5. A crankcase air-pressure control device for
internal combustion engines comprising a mem-
ber providing a lubricant condensing chamber
for lubricant-laden air said chamber being open
to atmosphere and having spaced ports for com-
munication with the crankcase interior and en-
gine controlled valve means in control of said
ports adapted for opening one of said ports in
the period of piston developed pressure in the
crankcase, to permit passage of lubricant-laden
crankcase air through said condensing chamber,
and for opening the other of said ports in the
period of crankcase suction, to effect suction re-
turn to the crankcase of lubricant condensed in
said chamber.

6. A crankcase air-pressure control device for
internal combustion engines comprising a mem-
ber projecting within the engine crankcase and
having a chamber therein open to the atmos-
phere, said member having spaced with spaced
ports affording communication between the
chamber and the crankcase interior lubricant
collector means in said chamber, and an engine
actuated rotary valve on said member, effective
for opening one of said ports in the period of
piston developed pressure in the crankcase, to
permit discharge of lubricant-laden crankcase
air through said chamber, and for opening the
other of said ports in the period of crankcase
suction, to effect suction return to the crankcase
of lubricant collected in said chamber by said
collector means.

7. A crankcase air-pressure control device for
internal combustion engines, comprising a mem-
ber extending into the engine crankcase and
providing a chamber therein open to the crank-
case exterior, said chamber having spaced ports
for communication with the crankcase interior, a

60 and through neck 63 and openings 68, and a somewhat shorter-period opening of the crankcase chamber to the spindle chamber 51 in the zone of chamber port 58, thereby registry of the gear hub aperture 59 with the port 58, occurring one-half a revolution later and as the piston approaches the head end of its stroke. In the first stage of its cycle function as above indicated, and when there is a tendency for the air in the crankcase to be under a pressure slightly above atmospheric as a result of piston displacement toward the crank end of its stroke, the control device then becomes effective to vent to atmosphere some of the crankcase air, whereby to relieve the slight, above-atmospheric air pressure in the crankcase so as immediately to restore the crankcase air pressure to atmospheric or sub-atmospheric value. Since in the normal function of the engine, some oil will be entrapped in the air thus released, this oil must be removed in the compression-relieving process. To this end, the spindle chamber 51 through which the above-laden crankcase air passes, serves in the preferred embodiment of the device, as an oil condensing chamber for removing some of the oil from the air vented therethrough. The oil thus condensed in the chamber, collects on and is absorbed by the felt pad 15 on screen 12, and hence is prevented from passing to the exterior of the device. The felt pad 15 being centrally disposed in chamber 51 and hence directly in the path of air flow therethrough, is of itself an effective agency for direct absorption of oil particles entrapped in the air vented through the chamber. Thus by the condensing function of the chamber 51 and the oil absorbing action of the pad 15 therein, a major portion of the oil in the vented crankcase air, will be removed for ultimate return to the crankcase. Such small portion of oil as may remain in the air attaining the chamber 14 and neck 63 of the attachment 60, will be condensed therein and will collect in the zones of chambers 14 and 51 below the screen 12. Similarly, oil accumulated by the absorbent pad 15 ultimately will drip through the screen into the lower portion of chamber 51. It is to be noted that the wire mesh screen 12 has an important function in the present assembly, in that it effectively prevents the air vented to atmosphere through the chambers 51 and 14, from picking up any of the oil accumulating below the screen.

In the second stage of the operational cycle, the gear aperture 59 registers with the lower spindle port 58 as the engine piston approaches top dead center and when there is a slight but appreciable suction or negative pressure in the crankcase as a consequence in part, of such piston displacement. Upon opening of the port 58, the oil accumulated in the chamber below the screen 12 and collecting in the zone of the port 58 by reason of the tapered form of chamber 51, will be returned by suction through port 58 and gear aperture 59 into the chamber 24 of crankcase extension 19, and thence into the engine crankcase. In the normal and intended function of the device, atmospheric air will not be drawn into the crankcase in this stage of operation, this by reason of the limited capacity of the port 58 and the relatively short period in which it is opened to the crankcase by valve port 58, which thus enables the lubricant pool in chamber 51 and above the port 58, to act as an air seal even during the suction return of a portion thereof to the crankcase.

proximate horizontally and inwardly therefrom, is a seat support or shield 40 which by preference, is formed integrally with the closure. The spindle is reduced as at 42 to provide a shoulder 43 and a gear journalling seat 44 over the inner longitudinal end portion of the spindle. Gear 26 rotatably received on spindle seat 44 and against shoulder 43, is formed to provide a cylindrical hub extension 45 having an end wall 47 transversely notched or recessed as at 48 for driving connection to the rearmost shaft coupling 23 by means of coupling lugs 50 engaged in the gear hub recesses 48 (Fig. 2).

The spindle 40 is interiorly recessed longitudinally thereof, to provide a chamber 51 open at its outer end 52 and closed at its opposite or inner end 54 by a spindle end wall 55 the chamber as shown by Figs. 2 and 3, preferably being of cylindrical form and tapered convergently toward the open end 52 thereof. Communication between the spindle chamber 51 and the chamber 24 in the crankcase extension 19 is effected through an upper inlet port 58 through the spindle wall at the inner end 54 of the chamber 51, and a diametrically opposite outlet port 58 of lesser capacity. The hub extension 45 of gear 26 which overlies the spindle portion in which the ports 56 and 58 are located, is here utilized as a rotary valve element for controlling port communication with the chamber 24 of the crankcase extension 19. To this end, the gear hub is provided with an aperture 59 preferably of a diameter equivalent to the diameter of the larger port 56 in the spindle, located for successive registry with the ports 56 and 58 during rotation of the gear 26.

A discharge or outlet attachment generally indicated at 60, is suitably removably secured on the external face of the closure member 33 in registry with the open end 52 of the spindle chamber 51, and includes a casing 62 and an upwardly directed discharge neck 63 open at its upper end 64. A protective cap or hood 66 overlying the open end of discharge neck 63 and protecting laterally on opposite sides thereof, as at 67 (Fig. 3), provides for downward air discharge through the openings 68. As indicated, the attachment casing 62 is sealed in its assembly connection to the closure 33 as by a suitable gasket element 70.

Opposed longitudinal channels 71 in the walls of the spindle chamber 51 afford a support for a removable screen 72 preferably of coarse wire mesh which extends horizontally through the chamber 51 and the chamber 14 provided by the attachment casing 62. Bearing on the upper surface of the screen 72 within the chamber 51 is an oil-absorbent member of felt pad 75 which may have its longitudinal margins 76 compressed in the channels 71, as shown. The pad further may be attached directly to the screen by a suitable clasp or staple element 78, so that the screen and pad may be inserted or removed as a unit.

In the operation of the presently improved crankcase air control device, the gear 26 is set initially such that its hub valve aperture 59 is in full registry with the upper spindle port 56, when the engine piston is near the crank end of its stroke. Thereafter and during engine operation, the gear 26 rotated from the crankshaft at engine speed, will establish successively, a relatively short-period opening of the crankcase chamber to the atmosphere through the chamber 24 of crankcase extension 19, gear valve aperture 59 in registry with spindle port 56, spindle chamber 51, chamber 14 of attachment or shield

UNITED STATES PATENT OFFICE

2,375,718

CRANKCASE AIR-PRESSURE CONTROL MEANS

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Application April 23, 1943, Serial No. 484,194

9 Claims. (Cl. 121—194)

This invention relates to crankcase air-pressure control means, and more particularly to an improved device for controlling air-pressure within a substantially closed crankcase of an internal combustion engine, pump, compressor or the like.

A principal object of the present invention resides in the provision of a novel and effective control device for substantially closed crankcases of engines and the like, which affords crankcase compression relief and air-pressure control in a manner generally to prevent above-atmospheric air pressures within the crankcase during engine operation, and more particularly, to facilitate maintenance of sub-atmospheric pressures in the crankcase, even to the extent of a slight negative pressure or partial vacuum therein, throughout at least a greater portion of each cycle of engine piston operation, whereby there is thus prevented or very materially reduced such loss of lubricating fluid from the crankcase interior, as otherwise would tend to occur by reason of above-atmospheric air pressure in the crankcase tending to force lubricant outwardly, as through cylinder ports, crankcase joints, and past such operating parts of the engine which extend through wall portions of the crankcase.

Another object of the invention resides in the provisions of a relatively compact and effective crankcase air control device of the character indicated, adapted for controlling the pressure within the crankcase by affording periodic air release from the crankcase during engine operation, wherein the device embodies a lubricant condensing chamber and lubricant absorbing means therein, for the removal of lubricant from the crankcase air released through the device, and controlled means for effecting return of the lubricant thus removed, to the crankcase.

A further object of the invention is to provide an improved device for the purpose indicated, which utilizes an operating part of the engine as an active element of the device, and which provides an oil entrapping and condensing shield at the outlet thereof, for inserting against discharge of oil particles into the atmosphere about the engine.

Other objects and advantages of the invention will appear from the following description of a preferred embodiment thereof as exemplified in the accompanying drawing, in which:

Fig. 1 is a longitudinal elevation partly in section, of an internal combustion engine embodying the presently improved crankcase air control device;

Fig. 2 is an enlarged sectional elevation of an upper portion of the crankcase, as taken from the line 2—2 in Fig. 1, showing the crankcase device therein, the view also illustrating a magneto device in driven connection with a drive gear in the crankcase portion shown, and

Fig. 3 is a sectional elevation through the device as viewed from line 3—3 in Fig. 2.

Referring to the drawing by suitable characters of reference, the improved control device in the embodiment presently preferred and herein illustrated, is shown by way of an example of its application, in association with an internal combustion engine of closed crankcase type, indicated generally at 10. Briefly, the engine shown by Fig. 1 includes a frame assembly providing a cylinder 11 and a crankcase 12, a crankshaft 14 in the crankcase, a piston 15 operable in cylinder 11, and a connecting rod 16 between the piston and crankshaft. A magneto generator 18 (Fig. 2) provided for supplying engine ignition current, is arranged externally to and preferably above the crankcase 12 adjacent an upward extension 19 of the crankcase. An opening 20 in one wall 22 of crankcase extension 19 affords projection of the magneto shaft coupling element 23 into the chamber 24 provided by the extension 19, for driven connection with a gear 26 therein forming an element of a gear train comprising cooperating gears 26, 27, 28 and 30. The latter gear 30 is located on and driven by the crankshaft 14, so that the magneto is operated from the crankshaft through the described gear train. For a purpose hereinafter to appear, the gear-drive ratio of the gear train is such that the gear 26 and hence the magneto shaft, will be rotated at engine crankshaft speed, although not necessarily in the same direction as crankshaft rotation.

Since the chamber 24 of extension 19 is in full communication with the main crankcase chamber 31, as appears in Fig. 2, the opening 20 receiving the magneto shaft coupling 23 therethrough, is sealed about the magneto frame extension 32 at the opening in any suitable manner as by a gasket indicated at 34.

The device of the present invention is located in the crankcase extension 19, as appears in Figs. 2 and 3, and employs the magneto drive gear 26 as an element thereof. An aperture 35 is provided in the outer vertical wall 36 of crankcase extension 19, giving access to the extension chamber 24, and this opening is normally closed by a removable closure plate or cover member 38 which is suitably sealed at the opening by a gasket 39 or like means. Centrally of the closure plate and

UNITED STATES PATENT OFFICE

2,417,195

SNAP-RING SECURED, DIVIDED MOTOR CASING

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Application June 30, 1943, Serial No. 492,925

7 Claims. (Cl. 171—252)

1

The present invention relates to assembly systems and more particularly to a novel knockdown assembly system and a novel method for its performance.

Conventional systems and methods used in assembling parts of apparatus, such as power units, signal units, electric motors, generators and the like within a housing or casing require numerous screws, bolts and other tool applied parts. Tools are also necessary in conventional systems to connect the component parts in bearing supports and other necessary supporting elements. Likewise, repair work requires disassembly of various parts with tools to fit special nuts and bolts requiring experienced disassemblers.

Such conventional apparatus assembly and disassembly methods and systems are arduous and time consuming and present a constant major problem to time study engineers. Time study engineers prior to the present invention, to meet production requirements, tried to solve the assembly problem in the usual way. They increased rapidity and efficiency of the various apparatus production to a limited extent by using groups of specially trained assemblers, assigning one group to assemble apparatus parts, another group to fasten bolts and screws and so on. Although the time study experts mathematically stepped up production and efficiency to a limited degree by increasing the quality and number of employed craftsmen, they also increased production costs.

Accordingly, a new solution amounting to more than a mere partial or intangible mathematical correction of the foregoing problem was in demand, as essential to obtain higher production efficiency. An object of the present invention, therefore, is to provide novel means whereby such higher production efficiency can be obtained. This highly desirable end is accomplished by providing novel apparatus adapted for rapid assembly and disassembly together with a novel method for its performance, permitting utilization of one unskilled worker, where two or more skilled craftsmen were required before, and to provide for a minimum assembly time even though the assembler is unskilled, thereby resulting in materially decreasing production costs.

Another object of the present invention is to provide novel apparatus adapted for rapid assembly and disassembly without the use of threaded parts, tools, etc.

A further object is to provide a novel assembly casing for electrical apparatus including a novel

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hand applied coupling arrangement, whereby rapid and efficient assembly of such apparatus without tools by inexperienced labor is made practical.

A further object is to provide a quickly assembled novel casing, whereby a plurality of demountable apparatus parts may be disassembled by a single demountable coupling member for repair and/or replacement of parts.

Still a further object of the invention is to provide novel knockdown devices such as motors, signal units, and the like without tool applied parts.

And yet a further object is to provide a novel knockdown motor or the like assembly case having interlocking sections, so shaped and so proportioned, as to hold the motor parts in operative assembled position when the case sections are interlocked and coupled together.

Another object is to provide a novel housing for motors or the like comprising a collapsible housing provided with interleaving sections which are adapted for rapid interlocking by means of hand operated clamping means.

The above and other objects and advantages of the present invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein two embodiments of the invention are illustrated. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and any devices described specifically are to explain the system and are not designed as a definition of the limits of the invention.

In the drawings, wherein like reference numerals represent like parts in the several views:

Figure 1 is a perspective view of a motor provided with the novel assembly of the present invention.

Figure 2 is a perspective view of the motor shown in Figure 1 with the outer casing sections uncoupled and slightly parted with the snap coupling ring detached.

Figure 3 is a side longitudinal view partly in cross section of the assembled motor; and

Figure 4 is a perspective view of another form of a novel casing which may be used in connection with a signal device, such as an electrical signal unit for use as an aircraft accessory device.

Referring to Figure 1 in detail, numeral 16 designates for example, an assembled electric device, such as a motor, generator or signal device which includes a sectional casing having two hol-

March 11, 1947. W. HARGREAVES 2,417,195

SNAP-RING SECURED, DIVIDED MOTOR CASING

Filed June 30, 1943 2 Sheets-Sheet 2

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SNAP-RING SECURED, DIVIDED MOTOR CASING

Filed June 30, 1943 2 Sheets-Sheet 1

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valve communicate with the crank case through the hollow rotary valve shaft (sleeve 21), in consequence of which the resultant added volume of gases to the crank case per revolution for supercharging amount to two times the area of the greatest diameter of the rotary valve multiplied by its axial movement.

From the foregoing description taken in connection with the accompanying drawing it is thought the construction, operation and advantages of the invention will be clear to those skilled in the art.

What I claim is:

1. In a two-cycle internal combustion engine having a cylinder, a crankcase, a piston and a crank shaft employing crankcase compression and wherein the fuel mixture is admitted to the crankcase and through a rotary valve, the improvement which comprises; an extension to the crankcase, said extension being in communication with the crankcase at one end of the extension, a rotary valve in said one end and serving as a closure therefor; means to move said rotary valve axially in said one end to increase and decrease the effective capacity of said crankcase; and means to pass fuel into the crankcase via said valve at suitable times.

2. In a two-cycle internal combustion engine having a cylinder, a crankcase, a piston and a crank shaft and employing crankcase compression and wherein the fuel mixture is admitted to the crankcase by and through a rotary valve, the improvement which comprises; a combined rotary and reciprocating valve; a housing for said valve in which the valve is rotatably and reciprocatingly mounted, said housing being in part functionally an extension of said crankcase; means to pass fuel into the crankcase via said valve when said valve is in one position; and means to rotate and reciprocate said valve by virtue of which the effective crankcase volume will alternately be increased and diminished for purposes described.

3. In a two-cycle internal combustion engine having a cylinder, a crankcase, a crank shaft, a piston operatively connected with said crank shaft, and means for delivering fuel to the crankcase the improvement which includes a body having a cylindrical passage divided into two chambers by a suitable partition that is in turn provided with a valve-sleeve bearing; a rotary valve in said body and comprising two end discs, one located in each chamber and connected by a sleeve open at its end adjacent the crankcase and closed at its other end against atmosphere, said sleeve adjacent said other end having ports communicating with the second of said chambers at places between said partition and the adjacent end disc; a fuel mixing and delivering duct in said partition communicating with said valve sleeve, said valve sleeve having a port to register with said fuel duct at times; and means to rotate and simultaneously reciprocate said valve.

4. In a two-cycle crankcase-compression engine having a cylinder, a crankcase, a piston, a crank shaft and a piston rod, said crankcase having a valve-controlled fuel inlet, the improvement which includes; a valve-compressor cylinder, said valve-compressor cylinder having a V-shaped partition with a valve-sleeve bearing and dividing said valve-compressor cylinder into two chambers, one of which chambers communicates directly with the interior of the crankcase and the other chamber is remote from the crankcase;

a combined valve and compressor-piston in said valve-compressor cylinder and including two end piston-discs connected by a sleeve one end of which communicates constantly with the crankcase and the other end of which communicates directly with the space between the piston disc that is in the remote chamber and said V-shaped partition; a fuel duct through said partition to said sleeve; said sleeve having a port for communication with said fuel duct at times; and means to rotate said combined valve and compressor-piston on its axis and reciprocate it along its axis to cause said port to register with said duct and to super-charge the crankcase with fuel at times.

5. The engine of claim 4 wherein the means to rotate said combined valve and compressor-piston on its axis and reciprocate it along its axis comprises shoes on said discs for engaging the respective faces of said V-shaped partition, and cams to rotate said valve.

6. In a two-cycle crankcase-compression internal combustion engine having a cylinder, a piston, a crankcase, a crank shaft and a connecting rod; the combination with the aforesaid structure of means for admitting fuel to and supercharging the crankcase with fuel, said means including a fuel duct; an auxiliary cylinder connected to the crankcase; a combined fuel admitting and fuel charging valve in said auxiliary cylinder, said valve having a fuel passageway and a port for registering with said fuel duct; and means to turn said valve on its axis and move the valve along its axis for purposes described.

7. The engine of claim 6 wherein the means to turn said valve on its axis and move the same along its axis comprises a crank pin on said combined valve and operatively connected through said crank shaft for turning said valve and cam means to reciprocate said valve along its axis as the valve is being turned.

8. In a two-cycle crankcase-compression internal combustion engine having a cylinder, a piston, a crankcase, a crank shaft and a connecting rod; the combination with the aforesaid structure of means for admitting fuel to and supercharging the crankcase with fuel, said means including a fuel duct; an auxiliary cylinder connected to the crankcase; a combined fuel admitting and fuel charging valve in said auxiliary cylinder, said valve having a fuel passageway and a port for registering with said fuel duct; and means to turn said valve on its axis and move the valve along its axis for purposes described, said last named means comprising a crank pin on said combined valve, operatively connected to said crank shaft for turning said valve and cam means to reciprocate said combined valve along its axis as it is being turned, said cam means comprising a V-shaped member having a valve bearing in which said combined valve rotates, said combined valve including end discs and shoe-carrying elements swivelly mounted on each disc and engaging said V-shaped member at diametrically opposite points.

9. In a two-cycle crankcase compression engine; means to control the admission of fuel into the crankcase and supercharge the same, said means including a combined rotary valve and fuel charger unit and means to operate the same to charge additional fuel into the crankcase on the compression stroke of the engine.

HENRY PORSTER.

UNITED STATES PATENT OFFICE

2,404,833

TWO-CYCLE INTERNAL-COMBUSTION ENGINE

Henry Forster, Broadview, Ill.

Application March 15, 1945, Serial No. 582,855

9 Claims. (Cl. 123—73)

1

My invention which relates to two-cycle engines primarily has for its object to provide improved means for supercharging the crank case with workable mixture.

Further it is an object to provide a simple, effective and inexpensive means which is especially adapted for use in model engines used on model airplanes, etc. Engines of the kind just referred to usually employ a rotary valve for controlling the fuel admission to the crank case and my invention involves the use of a combined rotary valve and compressor unit which not only controls the fuel admission but also assists the piston to compress a greater charge than that usually drawn into the crank case for compression by the piston.

Again it is an object to provide an improved means to increase the volume of the crank case while the piston is on its suction stroke and, after the crank case has been filled with working mixture by the suction of the piston, force the increased volume of fuel into the normal crankcase space to be compressed by the piston on its compression stroke.

Other objects will in part be obvious and in part be pointed out hereinafter.

To the attainment of the aforesaid objects and ends the invention also resides in those novel details of construction, combination and arrangement of parts all of which shall be first fully described hereinafter and then be specifically pointed out in the appended claims, reference being had to the accompanying drawing in which:

Fig. 1 is a central vertical longitudinal section of an engine embodying my invention.

Fig. 2 is a detail side elevation of the rotary valve with the piston disc omitted.

Fig. 3 is an end elevation of the same.

Fig. 4 is a detail cross section on the line 4—4 of Fig. 3.

In the drawing in which like numerals of reference indicate like parts in all the figures, represents the cylinder of an engine of the type hereinbefore mentioned. The piston 2 carries a wrist pin 3 to which one end of a connecting rod 4 is pivoted, the other end of the rod 4 being pivoted to the crank 10.

The crank case 5 is preferably cast integrally with the cylinder 1 and has one end wall provided with a bore 14 for a purpose presently explained. The crank case has a shaft bearing 6, suitably bushed as at 7 to receive the crank shaft 8. The shaft 8 has a crank disc 9 and the crank 10. The crank 10 is hollow and is bushed at 11 to receive the crank 32 of the rotary valve.

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A piston-controlled by-pass 12 conveys the compressed mixture from the crank case into the cylinder 1 above the piston. The exhaust port and duct is shown at 13.

The valve-compressor housing 16 has a reduced end 15 which fits tightly into the bore 14 and the cylinder 16 is secured to the crank case by cap screws 18 passing through bores in the crank case and tapped into ears 17 on the cylinder 16. The housing 16 is divided into two parts by a V-shaped-in-cross-section partition 21 the inner face 19 of which is a plane surface inclined upwardly-inwardly while the outer face 20 inclines upwardly-outwardly, the angles of inclination of the faces 19 and 20 are the same.

22 indicates the fuel intake duct whose flared end 23 admits air. A gasoline nozzle 24 held in a boss 25 supplies the combustible and with the air constitutes the fuel which passes down the duct to the valve sleeve 27.

The valve sleeve 27 has a port 28 to register with the lower end of the intake duct 22 at times. It also has ports 29 communicating with the space between the partition 21 and the piston disc 35 that is secured to the threaded end 30 of the closed end of the valve sleeve, a jamb nut 36 being provided to prevent the piston disc 35 coming loose.

At the open end the sleeve 27 is provided with a disc 31 that moves as a piston in the uppermost bore of the cylinder 16 while the disc 35 acts as a piston in the outermost bore of the cylinder 16.

A ball 33 is mounted on the disc 31 and carries a shoe 34 that lies against the face 19 of the partition while a ball 37 is mounted on the disc 35 at the side diametrically opposite that where the ball 33 is located, and carries a shoe 38 that lies in contact with the face 20 of the partition 21.

As the crank shaft 8 rotates during its normal operation, it rotates and drives, by means of the crankpin 32, the rotary valve. The rotary valve, due to the two ball joints 33 and 37 and shoes 34 and 38, acting on the stationary cam (the V-shaped partition 21) is forced to move axially in a reciprocating manner. At a predetermined position of the crankshaft, port 28 in the rotary valve, communicates with the carburetter intake (tube 22) for admission of the fuel mixture. With the crankshaft rotation continuing, the rotary intake port 28 closes, whereupon the rotary valve, moving in an axial direction toward the crankshaft, decreases the volume of the crankshaft space 39.

The four ports or passages 29 in the rotary

July 30, 1946. H. FORSTER 2,404,833

TWO-CYCLE INTERNAL-COMBUSTION ENGINE

Filed March 15, 1943

FIG. 1.

FIG. 4.

FIG. 3.

FIG. 5.

Henry Forster.

Oliver & Dietrich.

slanted with a retarded spark, as is desired for cranking, by means of the governor weight 4, which then occupies the full line position shown in Fig. 1. As the engine speeds up, centrifugal force moves weight 4 to the dotted line position shown in Fig. 1 and advances the spark by shifting cam 24 in the direction of rotation (clockwise as viewed in Figs. 2 and 4).

For the purpose of simplicity of disclosure only one governor weight has been shown. As a practical matter, a second governor weight, operating with the first weight so as to always balance the latter, might be used or the one governor weight might be otherwise counterbalanced. This counterbalancing is old and well understood in the art so that illustration of it here is thought unnecessary.

The automatic spark control mechanism of this invention is characterized by its extreme simplicity. There are very few parts and each part is simple and capable of being easily and cheaply produced. The assembly of these few parts is also simple and capable of being performed quickly and easily. Before the flywheel is placed on the crankshaft, the shaft 2 is pushed into its hole in the hub of the flywheel, working from the inside of the flywheel. Then the weight 4 is pinned to the protruding end of the shaft 2 and this holds the shaft axially in position. The limit pins 8 and 9 are driven into the flywheel and spring 7 is applied to hold the weight in retarded position. The cam 24 is then turned on the crankshaft into retard position, after which the flywheel is thrust axially on the shaft with the crankpin of crank 3 entering groove 6. The flywheel is then put in place on the crankshaft 25 and fastened as indicated to complete the assembly.

This spark control mechanism occupies so little space inside the flywheel as to be negligible for all practical purposes. Only the crank 3 extends into the space inside the flywheel and, even then, the crankpin 5 located in the slot 6 in the cam and therefore does not occupy any additional space. The crank arm is of very small volume and occupies very little space, merely a small corner near the inner end face of the flywheel hub. And only a small space is needed to enable this crankarm to swing throughout the desired range. Then also the small space needed would otherwise be unoccupied. The automatic spark advance can thus be applied to a standard flywheel magneto without requiring any change other than the slotting of the breaker cam and the omission of the key or pin which formerly held this cam to the crankshaft.

I claim:

1. The combination in a flywheel magneto with the flywheel and its crankshaft, of a breaker cam mounted to turn on said shaft, a small shaft rotatably mounted in the flywheel in parallel and closely adjacent relation with said crankshaft, said second-named shaft having its inner end extending into the space within the flywheel and engaged with said cam to turn the latter on the crankshaft when the second-named shaft is turned and having its outer end extending outside the flywheel, a governor weight mounted outside the flywheel and connected to turn said second-named shaft back and forth when the weight swings outwardly and inwardly by centrifugal force, and yieldable means acting on said weight in opposition to centrifugal force.

2. The combination in a flywheel magneto with the flywheel and its crankshaft, of a breaker cam mounted to turn on said shaft, a small shaft rotatably mounted in the flywheel in parallel and closely adjacent relation with said crankshaft, said second-named shaft having its inner end extending into the space within the flywheel and having a crank, said cam having a slot in its periphery in which the crankpin of said crank is engaged, whereby to turn the cam on the crankshaft when the second-named shaft is turned, said second-named shaft having its other end extending outside the flywheel, a governor weight mounted outside the flywheel and connected to turn said second-named shaft back and forth when the weight swings outwardly and inwardly by centrifugal force, and yieldable means acting on said weight in opposition to centrifugal force.

3. The combination in a flywheel magneto with the flywheel and its crankshaft, of a breaker cam mounted to turn on said shaft, a small shaft rotatably mounted in the flywheel in parallel and closely adjacent relation with said crankshaft, said second-named shaft having its inner end extending into the space within the flywheel and having a crank, said cam having a slot in its periphery in which the crankpin of said crank is engaged, whereby to turn the cam on the crankshaft when the second-named shaft is turned, said second-named shaft having its other end extending outside the flywheel, a governor weight fixed to said last-named end of the second-named shaft, stops for limiting the swinging movement of said weight, and spring means for holding said weight in its innermost radial position and against one of said stops.

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July 22, 1947. M. PIRY 2,424,416

ENGINE COOLING SYSTEM

Filed Jan. 6, 1944 3 Sheets-Sheet 3

Fig. 3.

Fig. 4.

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ENGINE COOLING SYSTEM

Filed Jan. 6, 1944 3 Sheets-Sheet 2

Fig. 3.

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ENGINE COOLING SYSTEM

Filed Jan. 6, 1944 3 Sheets-Sheet 1

Fig. 1.

Fig. 2.

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lar groove therein spaced equally from the rim of each bell lug, said coupling spring normally holding the ends of each groove of each bell lug out of alignment, until said bells are pushed together, and a coupling ring adapted to snap within the annular groove formed by such alignment, so as to press against the walls of said grooves in the direction of each bell lug rim in response to the expansion of said coupling spring.

3. A knockdown device comprising interengaging assembly sections, support means in each assembly section, a coupling spring, a seat for said spring associated with one of said assembly sections, means adapted to be seated in said support means of the other assembly section extending therefrom adapted to extend into said first assembly section adjacent said coupling spring seated therein, whereby to pilot said inter-engagement of said sections and compress said spring when said sections are inter-engaged, and coupling means adapted to hold said sections coupled together against the expansion of said coupling spring when compressed between said seat and said means seated in said support means of each inter-engaged section.

4. A knockdown apparatus assembly comprising a casing having a pair of interlocking sections, a rotor shaft, a bearing socket in each section, resilient means in one of said bearing sockets to prevent end thrust of said rotor shaft, an annular flanged portion in each section adapted to form a stator supporting chamber when said sections are together, a second resilient means normally adapted to resist interlocking of said sections, a plurality of staggered transversely grooved interlocking members associated with each interlocking section adapted when pushed together to form a complete annular groove, and a snap ring adapted to interfit within said annular groove in the interlocking members, whereby said grooves of each staggered interlocking member are maintained in substantial alignment against the longitudinal thrust of said second resilient means to thereby secure the above apparatus parts in operative assembled position.

5. An assembly casing for knockdown motor parts or the like comprising a pair of bell members, one of said bell members having an apertured outer flanged head portion and a rim with a plurality of perpherally grooved lugs, the other of said bell members having a rim with a plurality of perpherally grooved lugs adapted to interlock with said grooved lugs of said bell with the flanged head in thereby define an annular

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groove around the circumference of said interlocked bells, circumferential coupling means adapted to fit in said annular groove to couple said lugs together against accidental separation, and a plurality of cooperatively opposed sockets and flanges within each bell member adapted to hold said knockdown motor parts or the like together in assembled position, when the said bell members are coupled together.

6. An apparatus casing comprising, part supporting members having end walls and interfitting portions, resilient means tending to separate said members and parts, and separable means circumscribing said members at the interfitting portions and inter-engaging therewith to couple said members together against the action of said resilient means and adapted to hold the latter compressed and to be held under tension thereby.

7. An apparatus casing comprising, part supporting members having end walls and interfitting grooved portions, which when interlocked form a continuous peripheral groove, resilient means tending to separate said members and parts, and a resilient snap ring circumscribing said members at the interfitting portions and inter-engaging the peripheral groove formed to couple said members together against the action of said resilient means adapted to hold the latter compressed and to be held under tension thereby.

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low bell sections **16** and **17** coupled together by a snap or split spring coupler ring **15**.

Each bell section is identically constructed both exteriorly and interiorly, the only distinction residing in the position of the resilient elements, hereinafter described, housed in bell section **17**. Bells **16** and **17**, see Figures 2 and 3, the latter being a twin of bell **16**, may be any suitable shape, such as a cylinder having a centrally apertured top portion **18** with a raised annular end plate **19** defining the bottom of a bearing socket **20** formed within bells **16** and **17**, and an open bottom rim having a plurality of alternately spaced recesses or notches and protrusions, lugs or segments **21** and **22**.

Lugs or segments **22** are so shaped and so proportioned as to form an interlocking joint connection with lugs **21** of bell section **16**. The lugs **21** and **22** are arcuately grooved or provided with circumferential seats, as at **23** and **24**, better shown in Figure 2, so that when the two bell sections **16** and **17** are pressed tightly together the arcuate grooves **24** of bell **16**, and **23** of bell **17**, form one complete circle. Grooves **23** and **24** provide seats and lateral circumferential walls or surfaces **25** and **26**, **27** and **28**, that extend transverse the longitudinal ends of each lug.

Surfaces **25** formed by grooves **24**, and surfaces **26** formed by grooves **23**, are coupling surfaces designed to press against alternate opposite sides of snap or split spring coupler ring **15** when expanded, slipped over the sections and snapped or allowed to contract into the grooves. Such coupling action is generated by compression of normally expanded coupling, loading or biasing spring **29**, seated inside bell **17** on an annular flange **30**, see Figure 3, in cooperation with stator **31** seated inside bell **16** on an opposed annular flange **32**.

Seated in bearing socket **20** of bell **17** is a resilient member, as loading or biasing spring **33** in contact with a bearing **34**, which may be of the ball bearing type illustrated. Spring **33** tends to separate or force bearing **34** apart from the top portion **18** and end plate **19** of section **17** and prevents any longitudinal play or thrust of rotor shaft **35** journalled in bearing **34**, after the device is assembled.

Rotor shaft **35** is also journalled in a bearing **36** seated in socket **37** of bell **16**, rotor **38** being attached to shaft **35** intermediate the bearings **34** and **36**.

Positioned around rotor **38** is the stator **31**, which fits between bell sections **16** and **17** within annular counterbunk chamber **39** defined by annular flange **30** of bell **17** and annular flange **32** of bell **16**.

Assembly operation

Assuming for the sake of example, an electrical device, such as a motor is knocked down or is in disassembled form, the first step for complete assembly of the motor is to position the motor parts in bell member **17** as follows: insert spring **33** in bearing socket **20**, place the coupling spring **29** on flange **30**, insert stator **31** against spring **29**, secure bearings **34** and **36** to rotor shaft **35** on outer side of rotor **38** and then insert the bearing **34** within socket **20** against spring **33**.

After bell section **17** has been filled with the loosely positioned motor parts, bell section **16** is inserted over rotor shaft **35** and power cables **39** are threaded through a bushing **40** formed on bell **16**. Bell section **16** is then pushed together with bell section **17**, over the motor parts, so that bearing **36** seats in bearing socket **37** and lugs **21** and **22** of bell **16** interlock or interleave with lugs **22** of bell **17** in a dovetail or like joint.

Pressure is now applied to each bell section to overcome the resistance of coupling spring **29**, so as to compress spring **29** between flange **30** and stator **31** and so as to align grooves **23** and **24** end to end to form a complete circle or circumscribing groove or seat, and then snap ring **15** is inserted in the grooves and pressure is released. Upon release of manually applied pressure, the spring **29** expands and moves surfaces **25** and **26** of grooves **24** and surfaces **27** of grooves **23** in opposite directions, against the alternate opposite sides or side portions of coupling ring **15** and grip, the same to the extent of a slight distortion thereof tending to disalignment due to the engagement of alternate portions at opposite sides, to prevent accidental displacement of ring **15** from the grooves, see Figure 3.

In Figure **4** is illustrated a modified form of the novel casing which is adapted for use in connection with signalling units, and other accessory devices. An apertured flange **45** is formed with or secured to one of the end bells and is adapted to be secured to a panel, not shown, and cable openings **46** and **47** are elongated, so as to provide for projection of power cables from either the side or the top of the respective hub sections **48** or **49**. Otherwise, the device of Figure **4** is identical to that illustrated in Figures 1, 2, and 3, previously described in detail.

There is thus provided a novel apparatus assembly system and method eliminating all use of nuts, bolts, screws, and other threaded parts requiring the use of tools or any of the usual time impeding devices and which is simple, so that even unskilled labor may efficiently assemble or disassemble the apparatus in minimum time.

While only two embodiments of the invention have been illustrated and described, other changes and modifications which will now appear to those skilled in the art, may be made without departing from the scope of the invention. Reference is, therefore, to be had to the appended claims for a definition of the limits of the present invention.

What is claimed is:

1. A casing for power responsive devices comprising cooperating members, each of said members having a plurality of alternately spaced segments whereby the segments of one member inter-engage with the segments of the other member, arcuate surfaces carried by each of said segments whereby opposed continuous annular surfaces are defined when said segments are firmly inter-engaged, resilient means interposed between said sections adapted to resist said firm engagement of said segments, and an annular coupling member adapted to seat between said continuous annular surfaces defined by said arcuate surfaces, whereby the members are adapted to be coupled together firmly against resistance of said resilient means and said annular coupling member is held against accidental displacement by opposed pressures from said arcuate surfaces on each side thereof at opposed alternate points.

2. An apparatus casing comprising two bell members, a plurality of lugs around the peripheral rim of each bell, an annular flange at the base of said lugs within one of said bells, a coupling spring seated on said flange, a stator and rotor assembly mounted within said bells, said stator being adapted to seat against said coupling spring, each of said lugs having an annu-

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UNITED STATES PATENT OFFICE

2,424,416

ENGINE COOLING SYSTEM

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Application January 6, 1944, Serial No. 517,188

7 Claims. (Cl. 123—171)

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This invention relates to engine cooling systems and has particular reference to a system for cooling the cylinders of aeronautical engines, although the invention is not limited to that use.

It has been aeronautical engine cooling practice to obtain cooling air from the air stream induced by the propeller or by the movement of the airplane through the air, by collecting it in a substantially closed air scoop, either separately provided or arranged as part of the engine cowling, and having an air intake opening in the air stream. Owing to its velocity the air trapped in the scoop builds up a substantial static pressure, since the aggregate area of the restricted air exit openings between and around the cylinders is made less than the area of the intake opening of the scoop, or the outflow of air from the scoop is otherwise restricted or retarded as by friction or the like. The pressure air accordingly flows out of the scoop at high velocity over the cooling surfaces of the cylinders, which cylinders are provided with fins, spines or other projections to increase their cooling areas, and the cylinders are accordingly relatively uniformly cooled.

In air-cooled engines employing uni-directional cooling air flow, characterized by the fact that the same cooling air is used for cooling the front or upstream and the rear or downstream sides of the cylinder, the temperature of the cooling air is raised as the air progresses through the baffles, and unless provision is made to increase the rate of heat transfer per unit of temperature differential between the fins and the cooling air, the rear or downstream side of the cylinder must be expected to operate at a higher temperature than the front or upstream side, if a uniform heat abstraction is required all around the cylinder, as is usual. Furthermore, experiments have shown that the two portions of the cylinder barrel on which the two piston side thrusts, usually termed "thrust" and "anti-thrust," are applied, receive more heat than the rest of the cylinder barrel because of the heat generated by the friction between the piston and the wall and the heat transmitted by conduction from the piston to the cylinder wall through the piston skirt and, therefore, more heat must be removed by the cooling air over these two regions than over the rest of the cylinder barrel.

Because of the above considerations, it can be seen that the location of the piston thrusts on the cylinder barrel with respect to the direction of the cooling air flow has an important bearing on the cooling characteristics and the baffle design of an air-cooled engine. Nevertheless, all

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engines require an acceptable temperature distribution around the cylinder to avoid excessive distortion and wear. This condition must be met with the cooling air becoming progressively hotter as it proceeds through the baffles and with a heat rejection requirement which is decidedly non-uniform around the cylinder.

Accordingly, when the thrust and anti-thrust sides of the cylinder coincide with the front or upstream and rear or downstream sides of the cylinder, as in the case of an inline engine characterized from the cooling standpoint in that the cooling air flows across the cylinder bank in a general direction virtually perpendicular to the axis of the crankshaft, then the cooling requirements of the front or upstream and rear or downstream sides of the cylinder are greatly increased. Inasmuch as the cooler air engages the upstream or front side of the cylinder, the cooling of that side is not as acute a problem as that presented by the downstream or rear side of the cylinder, since that side receives warmer air previously used for cooling the upstream cylinder surfaces.

It has been found that the streamline or laminar air flow resulting from the usual prior cooling arrangements is not sufficient in many cases to provide adequate heat abstraction at the points requiring greater cooling, such as the aforementioned piston thrust and anti-thrust points, particularly when these points coincide with the upstream and downstream portions of the cylinder, as in the case of the inline engine described. However, a turbulent air flow may produce adequate cooling if properly controlled, notwithstanding the fact that turbulence causes a loss in air cooling pressure, a condition that has long been considered undesirable and inefficient. An example of an engine cooling system embodying turbulence-creating means that has proven very effective in improving the cooling efficiency of internal combustion engine cylinders, particularly the upstream sides thereof, is disclosed in copending application Serial No. 540,043, filed June 13, 1944, by D. B. Cox.

The present invention constitutes an improvement on that system, and also provides auxiliary or alternative arrangements producing the same or similar effects and consequent advantages by providing local turbulence over certain portions of the cylinder where a higher heat transfer per unit of temperature differential between the fins and the cooling air is required, either because the cooling air has been already warmed before reaching these portions or because more heat is to be rejected over said portions, or both, such as the downstream or rear sides of the cylinders

in inline engines, although the invention may be used with equal facility on radial engines, as will be described.

In accordance with the invention, such local turbulence is provided by wing baffles having sharp free edges projecting into the air stream flowing adjacent the finned cylinder of an internal combustion engine, so as to create turbulence in the air stream at points receiving more heat for mechanical reasons and thus requiring greater heat abstraction, or at points where the cooling air already preheated calls for a higher heat transfer coefficient. As stated, the local turbulence thus created results in a higher heat abstraction and an explanation of this enhanced cooling effect is that turbulence precludes the maintenance of a layer of hot air on the cylinder cooling surfaces that acts as a heat insulator. The violently turbulent air scours this layer of spent cooling air from the cylinder surfaces and fins, and rapidly and continuously takes its place, with the result that fresh cooling air is always present to remove the heat as rejected by the cylinder at the selected point.

In inline engines the local turbulence provided by these wing baffles will be required primarily at the downstream or rear sides of the cylinders for the reasons mentioned, and these wing baffles may be employed to advantage in conjunction with the turbulence-creating baffle arrangement disclosed in said copending application, which is particularly adapted to cooling the upstream or front sides of the cylinders. In this way the entire cylinder is not only more efficiently cooled by the turbulent air, but selected parts thereof requiring greater cooling or requiring equal cooling with the hotter air, are also locally treated with air whose turbulence is greatly augmented at the selected points.

In a radial engine, characterized from a cooling standpoint by the fact that the cooling air flowing across a cylinder bank has a general direction virtually parallel to the axis of rotation of the crankshaft, the piston thrusts are applied on the lateral sides of the cylinders in the plane of the cylinder row and then only the first of the aforesaid conditions exists, the maximum heat rejection being required on the lateral sides where the cooling air has not yet been considerably preheated. The cooling of the rear or downstream side of the cylinder will not be as critical as in an inline engine because one of the piston thrust points does not occur there, and local turbulence will be helpful primarily at the lateral sides to increase the total heat rejection as required because of the piston thrusts, and secondarily over the rear or downstream half of the cylinder to assure adequate cooling with the warmed air that is available. Thus, the large scale turbulence created by the propeller and generally accepted as sufficient for adequate cooling of the front of the cylinders of a radial engine, may be materially aided by local turbulence created at those points beyond the front sides of the cylinders in accordance with the invention. When the invention is adapted to a radial engine, each cylinder is preferably individually jacketed with the jacket providing smooth intake and exit openings and with the aforementioned wing baffles extending into the air stream for producing turbulence in the air stream at the selected points around the cylinder, preferably at the lateral or piston thrust and anti-thrust sides thereof, and if required, at the rear or downstream side thereof. The jacket plates are spaced from the cylinder fin tips so that the air flows turbulently not only between the fins but also around them to produce the enhanced cooling effect previously described.

It will be seen that, in accordance with experiments performed on engines, the engine cooling system of this invention provides improved temperature distribution around the cylinder, as well as greater evacuation of heat from the cylinder when a drop in pressure of the cooling air is available, this drop in pressure depending upon the design of the cowling and airplane speed. By providing the local air turbulence that is necessary to not only continuously supply pressure cooling air to selected cylinder surfaces, but also to remove the spent cooling air that tends to cling to the surfaces, greater engine efficiency is possible under all operating conditions.

For a more complete understanding of the invention, reference may be had to the accompanying drawings, in which:

Figure 1 illustrates semi-diagrammatically a horizontal section through a single bank inverted inline aeronautical engine equipped with the cooling system of this invention;

Fig. 2 is an enlarged section through a single cylinder of Fig. 1 equipped with the baffling arrangement of this invention, illustrating diagrammatically the typical turbulent flow of the air around and through the cylinder fins;

Fig. 3 is a transverse section through a cylinder of a radial engine equipped with the baffling arrangement of this invention;

Fig. 4 illustrates the manner of applying the invention to a radial engine; and

Fig. 5 is an end view of an inverted V-type of aeronautical engine showing the baffling arrangement of this invention applied thereto.

Referring to Fig. 1 of the drawing, numeral 10 designates a bank of six cylinders 11 in inverted inline arrangement, each equipped with the usual cooling fins 12, which term includes spines, or other equivalent cooling projections increasing the cooling surfaces of the cylinders. Enclosing one side of the cylinder bank 10 is an air scoop 13 of sheet metal, plastic, or the like, having the air intake opening 14 directed in the direction of travel of the airplane and preferably located in the slip-stream of the propeller, so that the air flows into the chamber 15 at a pressure higher than atmospheric pressure, or the pressure air may be otherwise supplied to chamber 15. The scoop 15 is accordingly located at the upstream side of the cylinder bank 10, which may also be considered the front of the bank from the cooling standpoint, since the air flows substantially transversely of the bank, i. e., from front to rear. It will be understood that the scoop chamber 15 is closed at the rear by fire wall 16 and extends inwardly to the crank-case at the top and to the camshaft housing at the bottom, so as to completely enclose one side of the cylinder bank 10.

A baffle plate 17, either one-piece or assembled, extends along the downstream side of the cylinder bank 10, being suitably secured to the crank-case and camshaft housing at its upper and lower edges, respectively. This baffle plate 17 is provided with slots 18, located opposite the axes of the corresponding cylinders 11 or otherwise, and fitted with outwardly turned flanges 19 providing a generally Venturi-shaped contour for exit slots 18, as shown. The exit slots 18 pref-

erably extend the full height of the cylinders, including head and barrel, or less, as required. The aggregate area of all of the exit slots 18 or of the passage area available at the location of the wing blades to be described is made less than the area of the air intake opening 14 of the scoop 13, so that a substantial static air pressure is built up within the chamber 15 by the kinetic energy of the inflowing air. However, the same effect may be obtained by making the said aggregate area smaller than the passage area of the scoop chamber 15 regardless of the area of the intake opening 14, the shape of which can be made to provide a Venturi tube effect so that the intake velocity is recuperated in the form of static pressure.

In the inline engine illustrated in Fig. 1, the piston thrust points coincide with the aforementioned front or upstream and the rear or downstream sides of the cylinders as indicated in Fig. 1, and since the rear side does not have unwarmed air available for cooling purposes, special cooling is required at the rear or downstream side of the cylinders in many cases. Accordingly, there are positioned adjacent the downstream or rear sides of the cylinders a plurality of wing blades or baffles 20 having sharp free edges projecting laterally into the air streams traversing the intercylinder spaces toward exit slots 18. As shown in Fig. 1, these wing baffles 20 are preferably positioned near the exit slots 18, and may be arranged at right angles to the lee baffle plate 17, as shown, although they may be otherwise positioned and in any required number, in order to intercept the air streams at points where greater cooling or greater heat transfer coefficient is required in order to attain the desired temperature distribution around the cylinders.

In operation of the engine cooling system of Figs. 1 and 2, and with particular reference to enlarged Fig. 2, it will be understood that the air within chamber 15 is under substantial static pressure and accordingly flows through exit slot 18 at considerable velocity.

After flowing between and over the fins on the front or upstream sides of the cylinders in bank 10, the air then flows between the cylinders with little turbulence, but inasmuch as the air tends to continue to flow in a straight line, it impinges against the flat surface of the lee baffle plate 17 and turbulence is created in the region approximately at 21, which might be termed a mixing space, since the air circulates vigorously and achieves a substantially uniform temperature.

As the air flows toward the exit opening 18, owing to the lower pressure at that point, it is intercepted by the wing baffles 20, which project into its shortest path from area 21 to the exit opening 18. As the air flows over the sharp intercepting edge of the wing baffles 20, its turbulence is increased in the manner shown by the arrows, between and around the fins 12, so as to scour off the layer of hot air tending to cling thereto, principally near the root of the fins. The inner ends of the flanges 19 are preferably reversely turned inwardly at 22, as shown, to further create turbulence prior to the streamline exit flow of the air through the Venturi exit slot 18.

It will be observed that the wing baffles extend inwardly to the tips of the fins 12, so that the air is caused to flow between them, and as the turbulence is created at the sharp edges of

baffles 20, it all takes place between the fins 12, this insuring that the scouring action is attained immediately at the cooling surfaces. If desired, the edges of the wing baffles 20 may be spaced slightly from the fins 12, so that some turbulent air flows over the tips of the fins. By means of these wing baffles 20, local areas of the cylinder are particularly well cooled and they may be placed at any point where such special cooling is required, and any number may be used at various points at the head or barrel of the cylinder. Also, the baffles 20 may extend the full height of the cylinders, or less, as required. For example, they may be located on the barrel only, or on the head only, or on parts thereof.

Referring now to Fig. 1, the spent cooling air issuing from the exit openings 18 into the low pressure chamber 23 formed by the cowling 24 is withdrawn through the exit gill 25 over which the slip-stream flows and thus creates a suction to promote the withdrawal of spent cooling air from chamber 23.

As previously stated, the wing baffle arrangement just described may be employed to advantage in conjunction with the turbulence-creating means of said copending application, in order to augment the turbulence created thereby and to provide turbulence at selected portions of the cylinders to which the turbulence created by said means may not reach or extend. To this end, the engine shown in Fig. 1 may be fitted with the turbulence-creating front baffle plate 26 such as is shown in said copending application. This front baffle plate 26 extends along and over the upstream side of cylinder bank 10, between the crank-case and camshaft housing, and is provided with vertical openings or slots 27 opposite the axes of the corresponding cylinders and extending the full height of the cylinders. The portions of the plate 26 forming the slots or openings 27 are sharp-edged, so as to create turbulence in the air flowing through them from chamber 15 into the space 28 formed behind the baffle plate 26, as aforementioned, and described in greater detail in said copending application. The aggregate area of slots or openings 27 is preferably greater than that of exit slots 18 although not necessarily so.

In operating the system of the present invention in connection with the front turbulence-creating plate 26, the air passing through slots or openings 27 from high pressure chamber 15 into space 28 is rendered turbulent by the sharp edges of openings 27 and scours the cylinders and fin surfaces. After passing around the widest part of the cylinders, the air strikes the lee baffle plate 17 and turbulence is recreated in the region 21 with wing baffles 20 increasing the turbulence before the air passes out of exit slots 18, in the manner previously described. The width of the front openings 27 may be adjusted with respect to the wing baffles 20 to secure turbulence of any desired degree at various selected parts of the engine cylinder, and it will be understood that wing baffles 20 may be placed at or near the openings 27 and in some cases may replace the front baffle plate 26 altogether. In short, the wing baffles 20 are extremely simple in construction and may be readily mounted at any point on the engine to obtain desired turbulence at any one or more points.

An example of use of the wing baffles near the upstream side of the cylinder in lieu of a front baffle plate like 26 in Fig. 1 is illustrated in Fig. 3, as applied to a radial engine, for example.

F.g. 3, in conjunction with Fig. 4, shows a double row radial engine, each cylinder 29 of which has the usual fins 30, but is jacketed by two half-baffles 31, which jointly substantially envelop the cylinder heads and barrels, being secured at their inner ends to the crank-case 32 and at their outer ends to the streamlined cowl 33. The space between jacketing baffles 31 of adjacent cylinders is closed by plates 34, which are sealed airtightly against cowling 33, as are the heads 35 of the jackets, as by gasket 36, so that the interior 37 of the cowling 33 forms an air scoop similar to the air scoop 13 of Fig. 1. The air stream entering the cowling opening 38 accordingly is blocked off by the jackets 31, plates 34, and gasket 36, so that it is constrained to flow into the jacket formed around each cylinder by the jacketing baffles 31, the air entering the opening 39, as shown in Fig. 3. The exit slots 40 formed between the two jacketing baffles 31 of all cylinders, or the passage available at the location of the wind blades aggregate an area less than that of the intake opening 38 of the cowling 33, so that a substantial static pressure builds up within chamber 37.

As shown especially in Fig. 3, the front edges 42 of the baffles 31 defining the intake opening 39 are curved outwardly and their rear edges are provided with outwardly-flaring flanges 43 imparting a Venturi shape to exit slot 40. The baffles 31 only closely engage the tips of the fins 30 of the cylinder 29 at the tangent point at the rear or downstream side, and are spaced therefrom elsewhere as shown at 44 in Fig. 3. Because the piston thrust points are located at the opposite lateral sides of the cylinders of a radial engine, in the plane of the cylinder row and transversely to the general direction of air flow from front to rear, as indicated in Fig. 3, the lateral sides of the cylinder require special cooling. To that end local turbulence in the air stream is created at these piston-thrust points in accordance with the invention. Accordingly, wing blades 47 and 48 are provided extending radially inwardly from the inner surfaces of the baffle plates 31 toward the fins at the lateral sides of the cylinder, as shown in Fig. 3.

In operation of the system of Figs. 3 and 4, the air enters opening 39 from chamber 37 at a greater pressure than that at which the air leaves the exit slot 40, and the air flows between the fins 30 and between their tips and the jacketing baffles 31 through the spaces 44 as shown by the arrows. The air then impinges upon the wing baffles 47, which extend to the tips of the cylinder fins 30, and hence the air flow is partly intercepted, so that considerable turbulence is imparted thereto as shown by the arrows in Fig. 3. The turbulence accordingly serves to scour off the spent hot cooling air which tends to cling to the cylinder and fin surfaces, especially near the root of the fins.

In its course further turbulence is imparted to the air by the following wing baffles 48 so that continued circulation and scouring results, after which the warm cooling air flows around and between the cylinder fins and out through the streamlined exit opening 40 into the spent cooling air chamber 49 for flow through the exit gills 50 shown in Fig. 4. High heat abstraction is thus obtained on the rear or downstream side of the cylinders of a radial engine where it is required because of the piston thrust in those sides and a high heat transfer coefficient is attained over the rear which makes it possible to assure cooling with already warm cooling air. The width and length of the openings 39 and 40, the distance between the tips of the fins and the baffles and the location of the wind blades, may be adjusted for suitable temperature distribution around the cylinders.

By adjusting the areas of the openings as described, and repositioning or increasing the number of wing baffles to create local turbulence, the system of this invention may be accommodated to the cooling requirements of any radial engine as well as of the inline engine of Fig. 1, and other types of engines to which the invention is applicable.

For example, the wing baffle arrangement of Fig. 1 may be applied with equal facility to an inverted inline V-type engine, as shown in Fig. 5, where two lee baffle plates 17' of the form shown in Fig. 1 and similarly fitted with flanges 19' defining exit slots 18', extend along the outer sides of the two banks of cylinders. These baffle plates 17' are fitted with the wing baffles or blades 20' adjacent the exit slots 18' and create turbulence in the air streams passing over them, in the manner described in connection with Fig. 1. If front turbulence-creating baffle plates 26' corresponding to front baffle plate 26 in Fig. 1 are desired, they are arranged to extend along the inner or upstream sides of the two cylinder banks, as shown. The cooling air scoop is formed by that portion 13' of the cowling extending between the camshaft housings 51 and having an opening directed in the direction of travel of the engine so as to collect cooling air which builds up a substantial static pressure within scoop chamber 15' by reason of its velocity and the enclosure thereof, including lee baffles 17' whose exit openings 18' or cooling air passage areas at the wing blades have an aggregate area less than that of the air intake opening. The remaining structure shown in Fig. 1 is employed in the V-engine shown in Fig. 5.

Although the invention has been illustrated and described in connection with certain inline, V, and radial engines, it is equally applicable to other types of internal combustion engines, and is otherwise susceptible of changes in form and detail within the scope of the appended claims.

I claim:

1. In an internal combustion engine having spaced cylinders located in an air stream, the combination of an air scoop for substantially enclosing one side of said cylinders and having an opening for directing a portion of the air stream into said scoop, a first baffle plate extending along and adjacent said one side of said cylinders providing openings opposite the cylinders, those portions of said baffle plate having relatively sharp edges projecting into the air streams flowing from said scoop through said openings for creating turbulence in the air flowing over said cylinders, a second baffle plate extending along and adjacent the opposite side of said cylinders and providing restricted openings for guiding said streams over the cylinders at relatively high velocity, and additional baffles on said second baffle plate projecting into said streams adjacent said passages for further creating turbulence in said streams flowing over said cylinders.

2. In an aeronautical engine having spaced cylinders located in an air stream, an air scoop for substantially enclosing one side of said cylinders and having an opening for directing a portion of the air stream into said scoop, a first baffle plate extending along and adjacent said one side

of said cylinders providing openings opposite the cylinders, those portions of said baffle plate having relatively sharp edges projecting into the air stream flowing from said scoop through said openings for creating turbulence in the air flowing over said cylinders, a second baffle plate extending along and adjacent the opposite side of said cylinders and providing restricted openings of less total area than the area of said scoop opening and the total area of said first baffle plate openings, whereby the air entering said scoop builds up a substantial pressure in the chamber between said scoop and the second baffle plate for causing said streams to flow over the cylinders at relatively high velocity, auxiliary baffles on said second baffle plate projecting into said streams adjacent said passages for further creating turbulence in said streams flowing over said cylinders, and flanges on said second baffle plate at opposite sides of said passages for conducting the spent cooling air therefrom.

3. In an internal combustion engine having a plurality of the cylinders provided with cooling fins and arranged side by side, the combination of means for conducting air against the upstream sides of the cylinders, comprising slots provided with sharp edges, baffle means at the downstream sides of the cylinders provided with slots disposed opposite said first mentioned slots and of smaller area than said first mentioned slots, and turbulence creating means located in the intercylinder stream of air.

4. In an internal combustion engine having a plurality of the cylinders provided with cooling fins and arranged side by side, the combination of means for conducting air against the upstream sides of the cylinders, comprising slots provided with sharp edges, baffle means at the downstream sides of the cylinders provided with slots disposed opposite said first mentioned slots and of smaller area than said first mentioned slots, and baffle means provided with a sharp edge located adjacent said fins at a point between said first and second mentioned slots.

5. In an internal combustion engine having at least one cylinder provided with cooling fins, the combination of means for conducting a stream of air under pressure to one side of said cylinder for flow therearound, a baffle plate at the other side of said cylinder extending toward and having an edge disposed closely adjacent to the fins of said cylinder, said baffle plate being arranged at an angle to said stream so that said stream impinges against said baffle plate to create turbulence in the air adjacent to said fins, and additional baffle means adjacent to said baffle plate and disposed between said air stream conducting means and said edge of said baffle plate, said baffle means projecting toward and having an edge disposed adjacent to said fins for intercepting said stream to direct said air between said fins and create further turbulence in said stream adjacent and between said fins.

6. In an internal combustion engine having at least one cylinder provided with cooling fins, the combination of means for conducting a stream of air under pressure to one side of said cylinder for flow therearound, baffle means at least partially enclosing the other side of said cylinder, said baffle means having edges closely adjacent to said cooling fins providing an opening adjacent said cylinder through which at least part of said stream flows, and additional baffle means interposed between said opening and said air stream conducting means extending toward and terminating closely adjacent to said fins to direct air between said fins and having a relatively sharp edge intercepting said stream for creating turbulence therein as it flows over and between said cylinder fins toward said opening.

7. In an internal combustion engine having at least one cylinder provided with cooling fins, the combination of means for conducting a stream of air under pressure to one side of said cylinder, baffle means at the other side of said cylinder having an opening therethrough having edge portions substantially in contact with the outer edges of said fins for guiding said air stream over said fins, and additional baffle means disposed on opposite sides of said opening and between said opening and said air stream conducting means and projecting inwardly toward and having free edges substantially in contact with said fins for intercepting said stream to create turbulence in the air flowing over and between said fins.

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INTERNAL-COMBUSTION ENGINE

Filed April 15, 1946 4 Sheets-Sheet 1

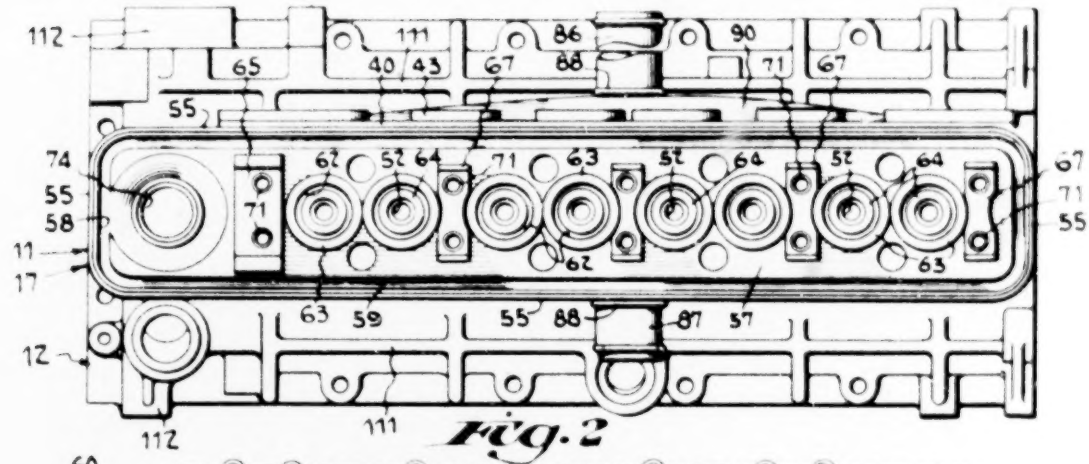

Fig. 2

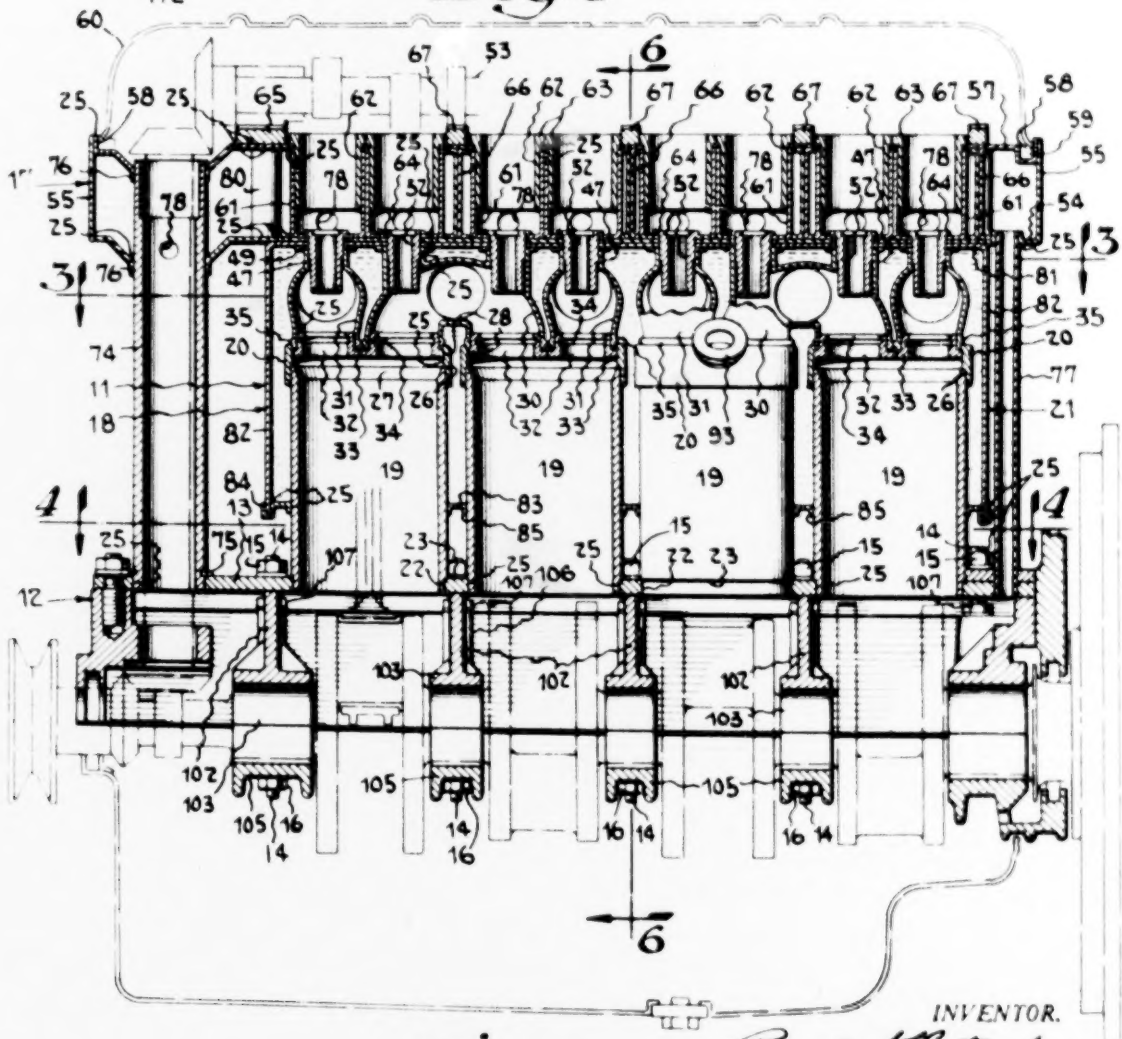

Fig. 1

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INTERNAL-COMBUSTION ENGINE

Filed April 15, 1946 4 Sheets-Sheet 2

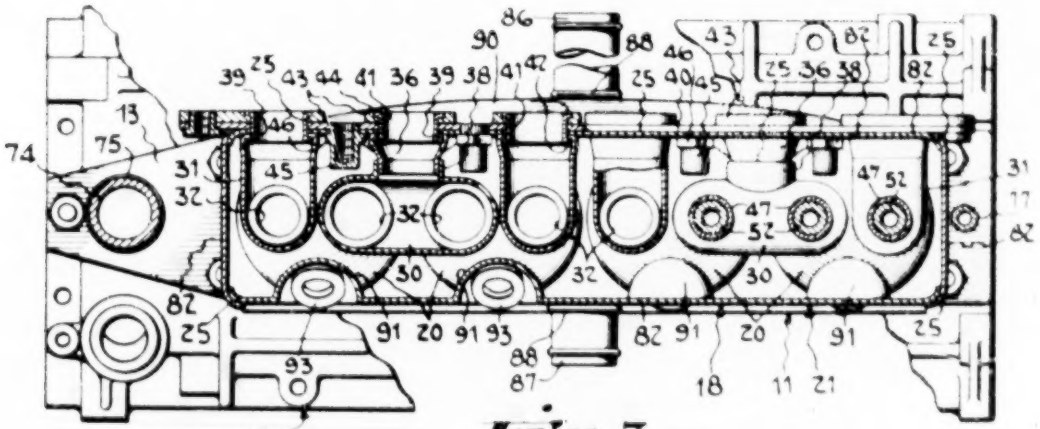

Fig. 3

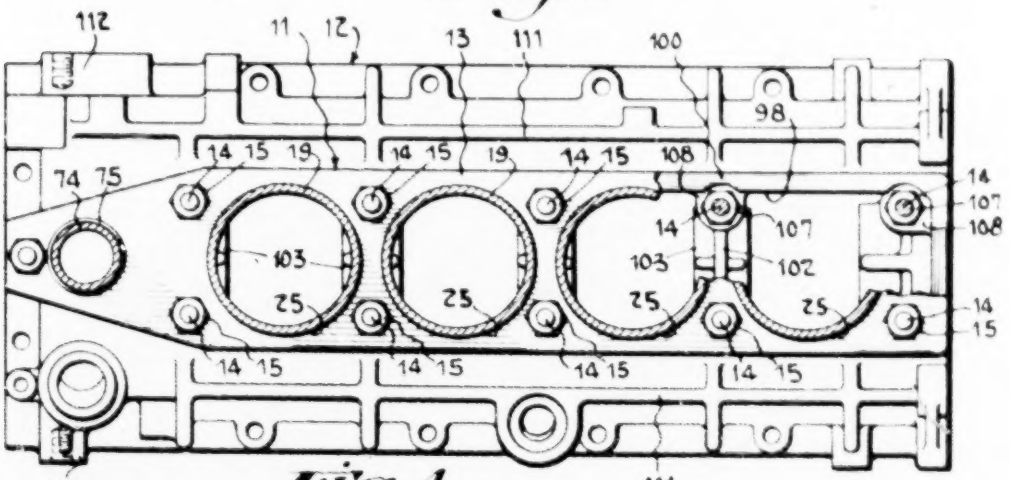

Fig. 4

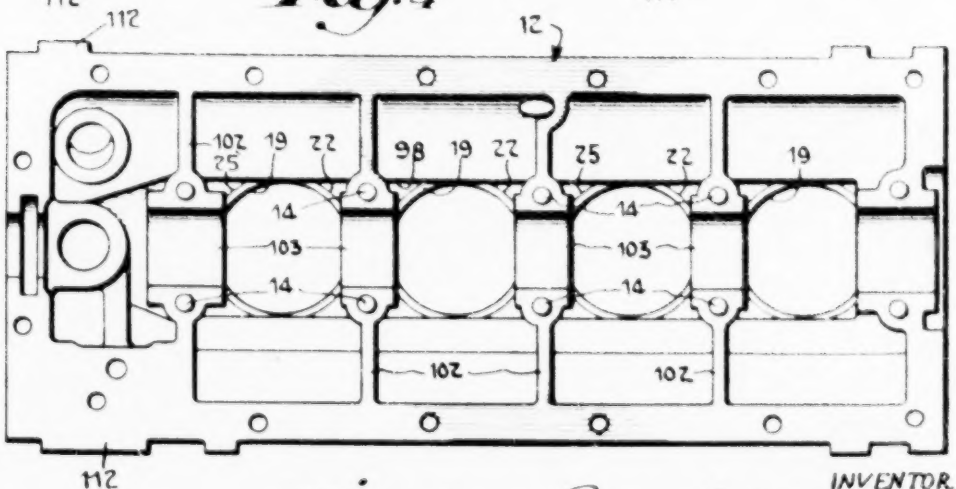

Fig. 5

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INTERNAL-COMBUSTION ENGINE

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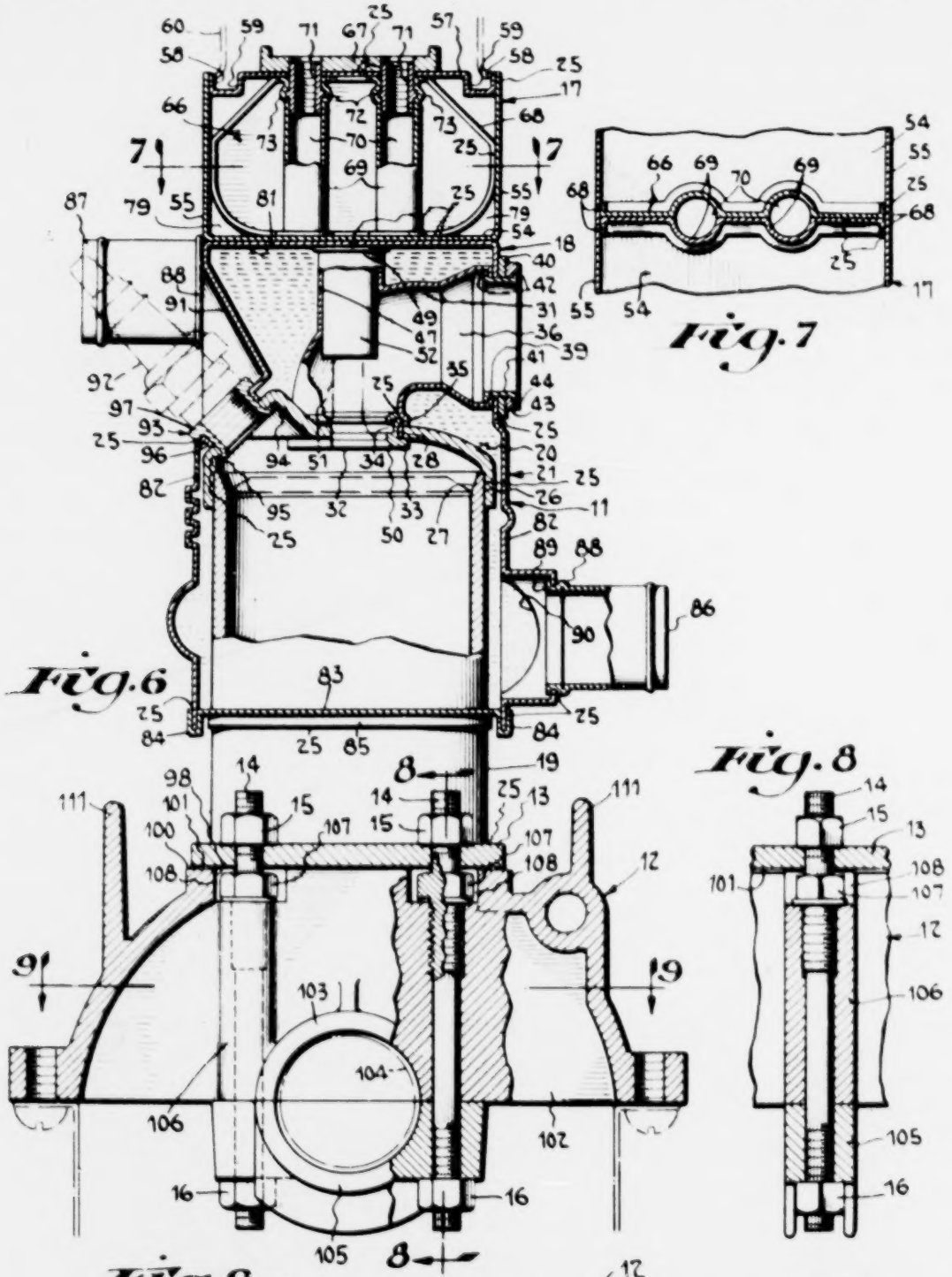

Fig. 6

Fig. 7

Fig. 8

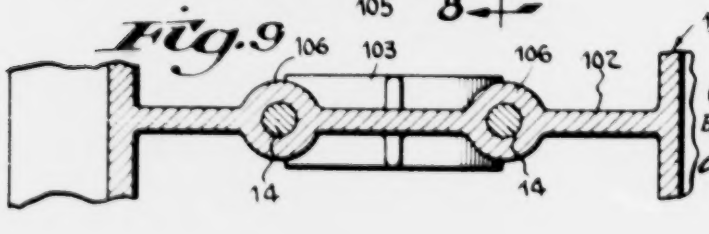

Fig. 9

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INTERNAL-COMBUSTION ENGINE

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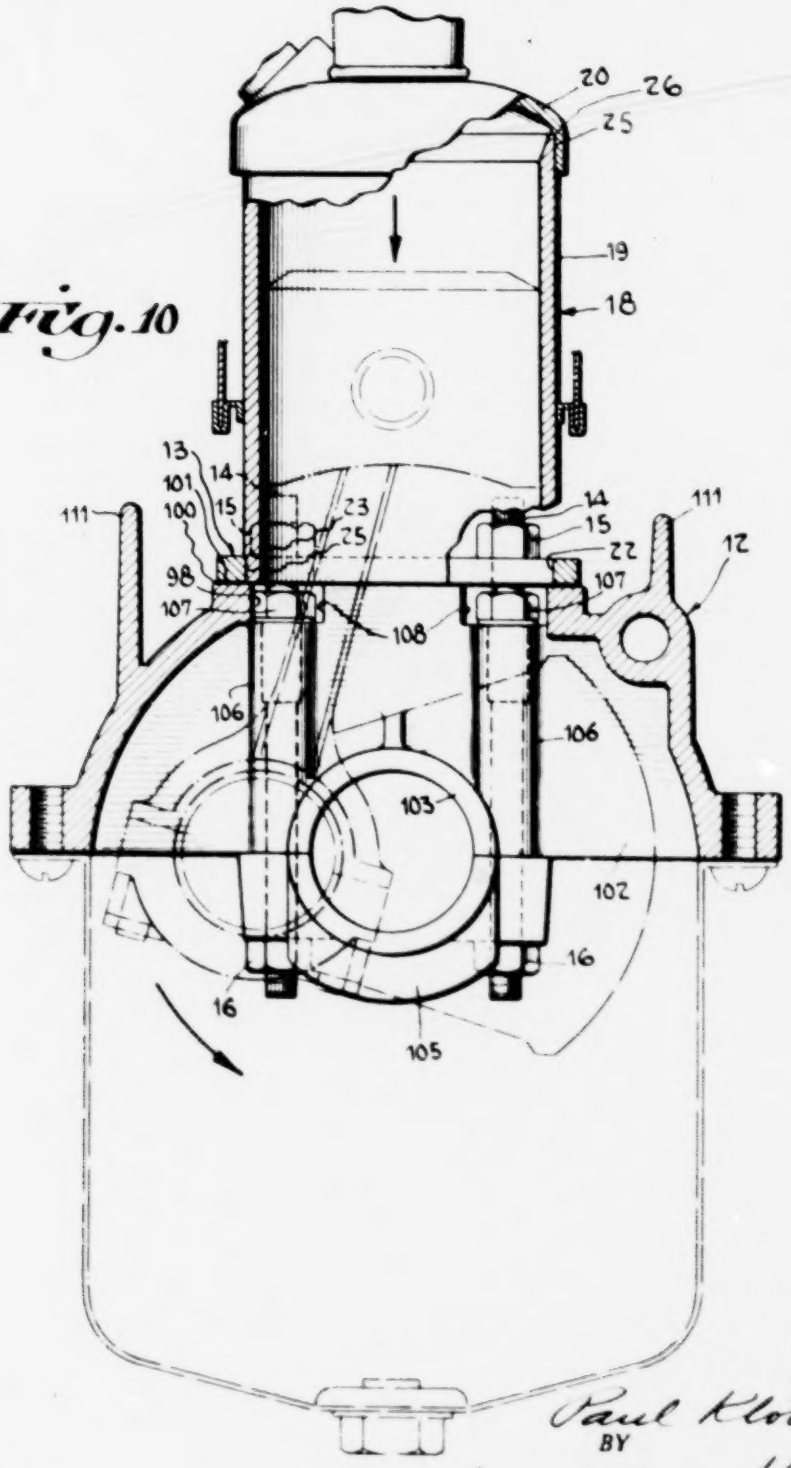
Fig. 10



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Patented June 13, 1950

2,511,823

UNITED STATES PATENT OFFICE

2,511,823

INTERNAL-COMBUSTION ENGINE

Paul Klotsch, Cincinnati, Ohio, assignor to Crosley Motors, Inc., Cincinnati, Ohio, a corporation of Ohio

Application April 15, 1946, Serial No. 662,323

18 Claims. (Cl. 123—195)

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This invention relates to an internal combustion engine and to a method of fabricating it. The invention is described particularly in relation to a four cylinder, four cycle, water-cooled gasoline engine suitable for use in a light automobile, but is suitable for many other uses such as for propelling motor boats, for driving dynamos and the like. Also, the structure of the engine and the principles involved in its fabrication are readily susceptible to use in engines of greater size and horse-power and in air-cooled engines, and in compressor machines.

The principal objective of this invention has been to provide an engine in which the strength and rigidity characteristic of a structure fabricated from castings or forgings are combined with the light weight, high efficiency, and low cost of manufacture of an engine fabricated from sheet metal stampings and thin wall members, without the disadvantages usually attending either type of construction.

Two main concepts of fabrication or production have been utilized to obtain this result. In the first place, the engine as a whole comprises a cylinder block which is constructed of stamped or formed thin wall elements or members, and a cast, or die-cast light weight crankcase which furnishes the foundation for the engine block. These two primary structural members are made separately and independently of one another and are fastened together by bolts and nuts. Together these static parts withstand all of the forces generated in the operation of the engine. Their functional cooperation in assembly provides a structure of high rigidity, both longitudinally and laterally.

The second of the main features of the invention is based upon the concept of associating the stamped or formed thin wall elements which form the engine block assembly by frictional or press fits, and then uniting the various elements one with another into permanent assembly by brazing. This principle of fabrication is employed throughout the engine block even including the assembly of those parts which are subjected to the most severe strains, and temperature, such as the cylinders and heads, the manifolds and valve seats, and the bottoms of the cylinders, one to another. In this manner threading and tapping operations are eliminated, no gaskets whatsoever are needed or used, and thin wall smooth surface sections are presented at critical areas subjected to high heat and high stress to contribute their high cooling efficiency to best advantage.

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In more detail, the engine block consists essentially of a simple flat base plate having cylinder tubes press fitted and brazed to bores therein. Each cylinder barrel, constituted by a thin-walled tube of alloy steel, has a thin-walled pressed steel cap or head at its upper end, the critical joint between the two being constituted by a brazed press fit. The upper or head ends of the cylinder barrels are cross braced, one to another, through truss-like bridges constituting manifold members which are press-fitted and brazed to the cylinder caps and, on top of this manifolding, a valve box is utilized comprising sheet metal elements which also are fastened together by brazing. By virtue of the strength and rigidity of the union of the cylinders with the base plate at their lower ends, and the union of the cylinder heads to the manifolds at their upper ends the valve box is relieved of the duty of furnishing additional strength and, therefore, is fabricated primarily with regard to cooling and to lubrication functions.

This assembly is contained within a sheet metal shell, the space between the shell and the cylinder tubes forming a water jacket encasing the circumference of each cylinder barrel, the cylinder head, the manifolds and the valves contained within the manifold. From top to bottom of the block, the assembly is devoid of gaskets at pressure areas. This construction is of utmost importance in relation to the problem of corrosion, for, if exhaust gases are permitted, through faulty gaskets, to escape into the water of the cooling system and water becomes acid and soon the metal becomes pitted and corroded. In a cast engine block having thick walls such corrosion is of no great importance but, where the metal parts are constructed of light gauge sheet steel it is apparent that the metal soon would be perforated by pitting of an otherwise minor nature, and the engine would be rendered useless. However, even uncontaminated water is corrosive to sheet steel more than to cast metal and it has been discovered that the corrosion from this source may be eliminated entirely by applying a thin continuous moisture and corrosion resistant film of resin over all of the interior water jacket surfaces by pumping resinous finishing material, in liquid form, through the water jacket, then draining the water jacket and baking the finish. The high heat transfer efficiency of the thin wall structural elements of the engine block permits this coating to remain unimpaired throughout engine

life despite the high combustion temperatures which exist within the cylinders and within the manifolds at the opposite sides of the metal members to which the coating is applied.

Except for the cylinder barrels and valve seats, the engine block members are formed of sheet steel; the barrels and valve seats are made of high carbon alloy steel capable of being hardened by quenching in air. For erection of an engine block constructed in this manner, the various parts are dimensioned together in self-sustaining frictional or press-fit engagement, brazing material is applied at the joint areas in suitable manner, and the assembly is then passed through a brazing furnace or brazing oven which has the double function of heating all of the parts to brazing temperature and of heating the cylinder barrels and valve seats to hardening temperature. Subsequently the assembly is air quenched to set the brazing material and, simultaneously, to lower the temperature of the cylinder barrels and valve seats below critical or hardening temperature, after which the assembly is allowed to cool slowly for relieving any strains that may have been set up in the brazing operation. This single operation therefore unites the parts and hardens those surfaces of the engine which are subjected to mechanical wear during operation.

The crankcase is a heat treated aluminum casting, except for heavy steel bolts which are set in it. These bolts are disposed in transverse webs, two bolts per web, the webs being located one on each side of each cylinder so that the base of each cylinder is nested among four heavy bolts. Each bolt protrudes above and below the web in which it is set and held against axial displacement.

The protrusion of the base bolts above the webs is utilized for attaching the flat base plate of the cylinder block to the crankcase upon which it bears. The protrusion of the bolts below their supporting webs is utilized to secure the lower half of each crank shaft bearing to the upper crankcase and, therefore, to the engine block. Consequently each crank bearing is sustained from the engine block just as though it were an integral part thereof. The crankcase therefore has only the primary structural duty of furnishing pads upon which the motor may be mounted to a chassis or frame, aside from its function as a housing for lubricant. As a result, it is very light in weight.

While the salient features of the present engine and the mode of fabrication have been discussed in the foregoing portion of the specification, other improvements of a somewhat more detailed nature also are disclosed in the following detailed description of the drawings in which a typical embodiment of the apparatus is illustrated.

In the drawings:

Figure 1 is a longitudinal vertical sectional view taken centrally through the cylinder block and crankcase assembly.

Figure 2 is a top plan view of the assembled cylinder block and crankcase.

Figure 3 is a longitudinal sectional view taken on line 3—3, Figure 1, illustrating the arrangement of the several intake and exhaust conduits and valve ports with respect to the cylinder heads.

Figure 4 is a longitudinal sectional view taken on line 4—4, Figure 1, showing the cylinders, base plate, crankcase, and the arrangement of studs securing the base plate to the crankcase.

Figure 5 is a view of the assembly of Figure 4 as seen from the bottom or crankcase side thereof, showing the crankcase construction and its relationship to the cylinder block assembly.

Figure 6 is an enlarged longitudinal cross sectional view taken on line 6—6, Figure 1.

Figure 7 is a cross sectional view taken on line 7—7, Figure 6, illustrating the construction of one of the struts in the upper portion of the cylinder block assembly.

Figure 8 is a vertical sectional view taken on line 8—8, Figure 6, illustrating one of the fastening studs with respect to the cylinder block base plate, crankcase and lower bearing cap.

Figure 9 is a horizontal cross sectional view taken on line 9—9, Figure 6, showing one of the stiffening webs of the crankcase with the studs located therein.

Figure 10 is a sectional view similar to Figure 6, showing the crankcase and cylinder assembly with the crank shaft, the connecting rod and piston being shown in phantom lines to illustrate the application of the explosive forces to the crank shaft with respect to the static parts of the engine.

The assembly shown in the drawings, in general, comprises a sheet metal cylinder block unit indicated at 11, and a crankcase indicated at 12. The cylinder block, as an integral assembly, includes a base plate 13 to which the lower ends of the cylinders are brazed. This base plate is seated upon the crankcase 12 and is secured in place by studs 14 and the nuts 15 thereon. The studs, which are preferably of alloy steel for high tensile strength, pass through the crankcase and are anchored at their lower ends in the lower bearing caps of the crank shaft bearings by means of the nuts 16 screwthreaded thereon. The pressure of combustion generated in the cylinders to force the pistons downwardly is of considerable magnitude, tending to force the cylinder block upwardly and the crankshaft downwardly. Since the crank shaft is carried by the lower bearing caps and the bearing caps are tied directly to the cylinder block by the studs 14 in tension, the disruptive stresses are substantially absorbed by the studs with little or no direct stresses in tension exerted on the crankcase.

Engine block 11, as shown in Figure 1, is, in effect, subdivided and consists essentially of an upper section, generally indicated at 17, providing support and housing means for the valve actuating mechanism, and a lower section, generally indicated at 18, including the base plate 13, cylinders, cylinder heads and valve bonnets or conduits.

The upper block section 17, in cross section, consists of a closed rectangular box-like casing with internal cross ribs and sleeves to resist the compression forces developed between the cam shaft and the lower ends of the valve springs. The compression pressure of the valve springs is imposed upon the bottom wall of the section 17 and the cam shaft is secured upon the top wall, thus setting up compression forces between the top and bottom walls tending to disrupt or force them apart. The structure is appropriately reinforced at the stressed areas to resist these forces substantially without deformation, and being an integral unit, absorbs the stresses and substantially isolates them from the lower section 18.

At the lower section of the block the cylinder barrels are received within bores in the base plate 13, in press-fitted relationship thereto, whereby

a joint is provided, after brazing, which is very strong, both laterally and longitudinally. It will be understood that the structure of the present invention is intended for use in the fabrication of multi-cylinder engines, the particular number of cylinders being optional. In the present disclosure a four-cylinder engine is illustrated but the identical construction is applicable to engines having a number of cylinders greater or less than four.

The upper ends of the cylinders include heads or closures 20 provided with valve ports, valve bonnets and spark plug bores. The upper portions of the cylinders, cylinder heads, and valve bonnets or conduits all are enclosed by a sheet metal water jacket 21 which is substantially rectangular in cross section; and the jacket includes a top wall upon which the upper section 17 is mounted. Water jacket 21 extends downwardly to cover the cylinder for the approximate area of piston travel and includes a lower wall through which the lower ends of the cylinders project to join the base plate 13.

Described in detail with particular reference to Figure 1 of the drawings, showing the complete assembly, the cylinder block unit 11 constituting a brazed assembly, is shown mounted upon the crankcase. The cylinders 19 of the cylinder block and the valve seats, are formed of seamless drawn steel or steel alloy tubing, having an appropriate wall thickness, for example, from $\frac{1}{16}$" to $\frac{3}{32}$", while the remainder of the elements are stamped from sheet steel.

The base plate 13 is formed from relatively heavy gauge steel, for instance, $\frac{1}{4}$" steel plate, having its bottom surface machined to provide a sealed joint with the upper surface of the crankcase. The plate includes a series of apertures 22 into which are fitted the lower ends of the cylinders 19. For the purpose of providing a stop to regulate the position of the cylinders in the plate, the cylinders are counterturned to provide shoulders, as at 23. With the cylinders located within the plate, a copper brazing ring is applied to the lower portion at the juncture of the cylinder with the base plate 13. This wire completely encircles the cylinder and when the assembly is heated in the brazing furnace, the wire fuses and flows into the crevice between the aperture and the base of the cylinder, completely filling the crevice and securely uniting the cylinder to the base plate. Similar brazed joints uniting various other parts of the assembly all are indicated by the numeral 25 throughout this description. Brazing paste may be used in place of copper or brazing wire when more convenient to apply.

The upper ends of the cylinders are provided with closures or cylinder heads 20 preferably formed of thin wall cold drawn steel stampings to facilitate rapid heat dissipation. The top of the cylinder heads are domed upwardly and the interior diameter of the flange of each cylinder head includes a counterbored portion 26 into which the upper end of the cylinder 19 is press-fitted. A brazing wire applied at this point encircling the cylinder, enables the brazing material to flow by capillarity into the crevice thereby providing a gas-tight seal and securely uniting the cylinder head to the cylinder.

The internal diameter of the cylinder at the upper portion may include a chamfer or outwardly tapered portion 27 merging generally with the inside wall of the cylinder head. The chamfered portion, starting at the lower line of juncture

with the cylinder wall and including the cylinder head, forms the combustion chamber for the engine, the line of the chamfer coinciding approximately with the upper limit of the piston travel. This arrangement avoids an excessive wall thickness at the joint and permits rapid cooling, the combustion chamber being substantially surrounded by the water in the jacket.

A further advantage, in relation to engine performance, is believed to be contributed by this detailed construction. Machining of the cylinder head by counterboring and machining of the cylinder barrel by counterturning to mating diameters providing a press fit, insures such continuity of contact between the two parts that, after brazing, an assembly is provided having the characteristics of an integral structure. This arrangement, therefore, enables attachment of the head to the cylinder through a bond which is sufficiently strong to sustain the high disruptive forces attending each explosion in the cylinder. On the other hand, this thin wall structure, coupled with the inward chamfer on the end of the cylinder barrel and the thin wall construction of the head, is believed to provide sufficient momentary yieldability or expansibility to prevent preignition of the fuel and knocking. While the exact force reactions occurring at the moment of explosion are not known, still it is believed that either the cylinder or head, or both, may expand outwardly enough to relieve the exceptionally high compression values which commonly are considered to attend the development of engine knock. At any rate, the engine does not knock, even under adverse load and adverse fuel conditions.

Each cylinder head 20 is provided with a pair of ports or openings 28—28 into which are fitted the valve bonnets, or conduits, 30 and 31 respectively, the bonnets 30 being for intake bonnet and the bonnets 31 being for exhaust. Fabrication of the valve inserts and valve bonnets and the assembly and joining of these parts to the cylinder heads is the subject matter of the co-pending application of Herbert P. Junkin for Metallic structures and method of fabricating same, filed September 13, 1945, bearing Serial No. 616,004, now Patent No. 2,486,654, to which attention is invited. A brief description of this construction is as follows:

Ports 28—28 include bushings or valve seat inserts 32, each bushing including a head or annular base 33 disposed at the inside of the cylinder, and a shank portion 34 extending upwardly above the top of the cylinder head. The head 33 seats against the inner side, serving as an abutment for the bushing. This head later is machined to form a valve seat.

The lower ends of the valve bonnets are provided with an external peripheral bead 35, the bead defining a rim designed to fit snugly within the ports 28—28, and also serving as a stop or abutment, bearing against the top surface of the cylinder head. At the interior, the rim telescopically receives the shank portion 34 of the bushing, the shank being pressed snugly within the rim portion of the conduit. The shank is then deformed by radially expanding a circumferential portion of it outwardly into the area of the bead 35, by means of suitable dies. Shank 34 is thus clinched to the bead 35. The assembled parts, by means of a suitable brazing ring, or subsequently bonded together in the brazing furnace, whereby the brazed joint 25 provides a strong gas and fluid tight seal.

As shown in Figures 1 and 3, the intake valve bonnets 30 connect the cylinder heads in pairs and are in the form of U-shaped conduits having lateral nipples 36 at their upper central portions. The nipples 36 extend through the water jacket 21. Conduits 36 are arranged to be connected to an intake manifold, which is not shown since it may be of conventional construction.

The lateral conduit 36 of each intake bonnet 30 is secured at its inner end by brazing as indicated at 25 (Figure 3), the conduit being provided with an annular flange 38 telescopically to receive the inner end of the conduit in press-fit connection. The conduit flares outwardly from this point and includes an annular inturned lip or flange 39 which lies against the inside surface of the water jacket 21 as shown in Figures 3 and 6.

A stiffener plate 40, formed of relatively heavy gauge sheet metal is brazed as at 25 to the outside of the water jacket 21 and extends for the full length thereof. This plate reinforces the jacket to permit it to support the weight of the exhaust and intake manifolds and facilitates attachment of the manifold outlets.

The flanges 39 of the lateral conduits 36 are engaged respectively by short thimbles or collars 41 having annular outwardly turned flanges, 42—42 at the opposite ends thereof. These collars are formed from seamless light gauge tubes, the flanges being formed by deforming or upsetting the ends. Ferrules or rings 43 are disposed at the outside of the plate 40 and include grooves 44 to receive the exterior flanges 42 of the collars 41. Thus, each collar 41 extends through its ring and through the openings in the water jacket and stiffener plate and the ends are upset to form the flanges 42—42, thus clinching the assembly securely together.

It will be apparent that the collars 41, in effect, form a liner sealing off the joints between the water jacket and stiffener plate, thus eliminating several joints, and additionally strengthening the assembly. After assembly, the joints are brazed as indicated at 25 to provide a gas and fluid tight seal.

As shown, an exhaust valve bonnet 31 is provided individually for each cylinder. These bonnets or conduits are in the form of right angle elbows, being respectively connected at opposite ends to the cylinder heads and outlet openings in the water jacket and stiffener plate to communicate with an exhaust manifold. These conduits are joined to the cylinder heads and to the stiffener plate, as shown in Figure 6, in the same manner as the intake bonnets 30 previously described.

From this detailed description, it will be seen that the upper ends of the cylinder barrels are joined together by the U-shaped rigid intake bonnets which are interconnected with the heads thereof. This holds the upper ends of the cylinders against longitudinal displacement with respect to one another. However, the upper ends of the cylinders also are connected by the right angle exhaust bonnets to the stiffener plate 40 and in view of the close spacing of the cylinders and bonnets the cylinders are thus prevented from lateral movement with respect to one another. This is of particular importance in view of the lateral thrusts to which the cylinders are subjected during successive power and compression strokes when the engine is in operation.

As previously indicated, the intake and exhaust manifolds may be of conventional construction and they are adapted to be fastened to the stiffener plate 40 by means of screws which engage a series of thimbles 45 extending into the interior of the water jacket. These thimbles are screw machine parts provided with shoulders 46 which abut the interior wall of the stiffener plate, the projecting portions of the thimbles being appropriately crimped and brazed in position so that they do not turn when the manifold screws are tightened. The screw threaded bores in the thimbles are blind and the escape of water at these points thereby is prevented. To facilitate gas-tight connection of the manifolds to the engine the faces of the ferrules 43 are machined to present a finished plane surface which preferably does carry a gasket. It is to be noted, however, that this gasket is beyond the confines of the water chamber and any leak might impair operating efficiency but will not cause corrosion problems.

In the preferred structure, the valve bonnets 30 and 31 are formed of light gauge sheet metal stampings, for example, metal approximately $\frac{1}{16}$" thick. Since the bonnets are not exposed to the direct combustion pressure in the cylinders, serving only as passageways for the vapor and burned gases when the valves are open, they are formed of light gauge sheet metal which facilitates rapid dissipation of heat to the cooling water by which the bonnets are surrounded.

At the top of each of the bonnets 30 and 31, an upwardly projecting sleeve 47 is formed integrally with the bonnet to contact the top wall of the water jacket at the underside thereof. The end of the sleeve includes a lateral flange 49 having facial engagement with the wall to strengthen the joint mechanically and to provide an increased sealing area with respect to the adjoining surfaces of the sleeve and water jacket wall. If desired, the flange 49 may be in the form of a flange formed integrally with the upper edge of the sleeve 47. The assembled joint is brazed, as at 25, to produce a strong and rigid water-tight joint between the wall and the top of the valve bonnet sleeve. Both the intake and exhaust valve bonnets are provided with identical sleeves 47, and the joint in each instance is formed as above described.

For a four cylinder engine fabricated in accordance with the present invention, each cylinder head includes respective exhaust and intake ports 28—28. The exhaust ports are provided with individual bonnets 31 and the intake ports are connected in pairs to the respective intake bonnets 30 each bonnet thus serving two cylinders. The valve inserts or bushings 32 are common to both sets of intake and exhaust ports and are identical in construction with the exception that the intake bushing is made slightly larger in diameter than the exhaust bushing for more efficient engine performance.

Levelled valve seats 50 are provided on the inner edges of the inserts 30 by machining after the engine block has been assembled and brazed. Thus, in Figure 1, the inserts are shown before machining, and in Figure 6, the inserts are shown after machining. These seats are engaged by poppet type valves 51 which are indicated by the broken lines on Figure 6. Both the valve inserts and cylinder bonnets, as previously indicated, preferably are made of a high carbon, air hardening alloy steel, such as "Athenu," and the seats and walls may be finished by grinding or lapping to form smooth true surfaces.

The stems of the valves 51 project upwardly and slide within valve stem guides (not shown) which are pressed into guide bushings 52 inserted and brazed in place within the sleeves 47 of the respective valve bonnets 30 and 31. The upper

ends of the valves 31 are provided with suitable springs, cam followers and guide mechanism (not shown) and are actuated by an overhead cam shaft 53 as shown in broken lines on Figure 1.

The upper valve housing unit 17 essentially comprises a rectangular casing having a bottom wall 54 and side and end walls 55. It is formed preferably of a light gauge sheet metal stamping, open at the top and subsequently closed by a cover plate 57 which is brazed in place after the interior parts of the casing have been assembled. For this purpose, the cover plate includes an upstanding marginal flange 58 which is adapted to fit within the side and end walls 55 of the casing to form a flanged joint, the surfaces being joined by brazing as indicated at 25. This arrangement further provides a trough or recess 59, approximately square in cross section, formed by depressing a marginal area adjacent the flange 58 and extending around the four sides of the cover plate. The recess 59 serves to retain a gasket (not shown) upon which is seated the lower edges of a top closure or cover 60, shown in broken lines on Figure 1.

Casing 17 as shown in Figures 1 and 2, includes a plurality of cylindrical drawn sheet metal receptacles or cups 61 disposed interiorly thereof, the bottoms of which rest upon the bottom wall 54 while the upper ends abut the underside of the cover plate 57 to which the upper ends of the cups are brazed. Each of the cups 61 is further provided with a prefabricated cylindrical sleeve or liner 62, which includes a head or flange 63 at the top providing a shoulder seated upon the top cover plate 57. The sleeves are telescopically fitted within the cups 61 and brazed thereto. These sleeves serve to house and guide the cam followers, the followers being of cylindrical form and making a sliding fit therein. The valve springs are under compression between the follower and the bottom of the cups 61. These parts form no part of the present invention and therefore are not shown in the drawings.

The valve guide bushings 52 are disposed in axial alignment centrally within the cups 61, extending downwardly through openings in the cups and through openings in the bottom of the casing and water jacket. The lower portion of each bushing fits telescopically within the sleeve 67 of the valve bonnets 30 and 31, as previously described. Each valve bushing 52 includes a head 64 at its upper end providing a shoulder which is seated upon the bottom surface of the cup 61 where it is brazed in place as at 25. In practice the valve inserts 32, guide bushings 52 and the cups and sleeves 61 and 62 are pressed into assembly as closely in axial alignment as is practicable. However, due to allowable tolerances and other variations incident to stampings of this nature and to production methods of manufacture and assembly, minor variations in the parts are likely to be present. In order to compensate for these variations, the valve inserts 32, guide bushings 52, and the cups and sleeves 61 and 62 are arranged to be machined in assembly and line reamed or ground and lapped to provide the necessary finish and clearance for efficient operation of the valve stems and associated parts.

In order to strengthen and rigidify the casing 17 and additionally to provide supports for the cam shaft bearings, a series of transverse struts or webs 66 (Figure 7) are disposed interiorly of the casing, each preferably being disposed immediately beneath a cam shaft bearing mounting

pad 67 respectively, a number of these pads being provided to support the cam shaft appropriately. The webs comprise relatively light sheet metal stampings, and each web is made up of two symmetrical stampings, preferably brazed together, providing oppositely extending right angle flanges 68 (see Figures 6 and 7). Each web is further provided with a pair of vertical semi-circular corrugations 69—69 which form cylindrical sleeves 70 when the opposite halves of the webs are placed face to face. The upper ends of the sleeves 70 are arranged telescopically to receive a threaded bushing 71, which extends through an opening in the top cover plate 57 and bearing block 67. The lower shank portion of each bushing includes a peripheral flange 72 engaged by a bead 73 formed in the upper portion of its cooperating sleeve 70. The threaded bushings 71 are arranged to receive the screws (not shown) for mounting the cam shaft bearings. This structure provides a rigid support for the bearings, there being provided one assembled web for each bearing respectively.

At the forward end of the casing 17 a main cam shaft bearing pad 65 is located. The mounting for this bearing is reenforced by means of a pair of cylindrical sleeves 80 preferably of light gauge sheet metal, brazed as at 25 to the upper and lower wall of the casing 17.

In assembly the webs 66 and flanges 72 of the sleeves are positioned within the beads 73, the two halves being secured together with the threaded bushings being disposed within the sleeves. The assembled webs are placed within the casing 17, the cups 61 and valve guide bushings likewise being in assembled relationship within the casing. After this the cover plate 57 is placed in position and the bearing pads 67 located upon the top surface of the plate in engagement with the projecting upper ends of the threaded bushings 71. The casing is now completely assembled in place upon the top of the water jacket and the various joints indicated at 25 are ready for brazing when the assembly is placed in the brazing furnace. The joint 25 between the water jacket and casing is formed preferably by a sheet of [illegible] material placed between the parts.

At the forward end of the engine a vertical tube 74 is provided to communicate with an opening in the base plate 13 at its lower end. This tube passes through the lower and upper walls of the casing 17 and at its lower end includes a flat washer 75 seated within a groove formed in the tube. The washer provides a shoulder which rests upon the upper surface of the base plate 13. This serves to position the tube properly with respect to the base plate and the tube is securely joined to the base plate by means of the brazed joint indicated at 75, providing a fluid tight seal at the base of the tube. The upper end of the tube is also joined to the casing by brazing, flanges 76—76 formed in the upper and lower walls 57 and 54 of the casing being used for this purpose.

Tube 74 houses a vertical drive shaft shown in broken lines shown in Figure 1. This shaft includes bevel gears at its upper and lower end respectively which mesh with bevel gears keyed to the crank shaft and cam shaft. The drive from the crank shaft is transmitted to the cam shaft in this manner.

The rearward end of the cylinder block assembly is likewise provided with a vertical tube 77, communicating with the interior of the casing

17 at its upper end and extending through the base plate 13 at its lower end to communicate with the crankcase. Tube 77 serves as an oil return conduit. The engine is provided in any suitable manner with an oil pump for maintaining a flow of oil from the crankcase to the cam shaft and the cam actuated mechanism which is associated therewith.

For lubrication, cups 61 are provided with openings 78 which permit the excess of oil to drain from the interior of the receptacle. This oil ultimately flows back to the crankcase through the return conduit 77. To permit the return of excess oil, the lower portions of the webs 63 are curved as shown in Figure 6 thus providing openings 79 permitting free passage of the oil.

The water jacket 21, shown in the drawings, consists essentially of sheet metal stampings generally rectangular in cross section comprising a top wall 81 and side and end walls 82, the side and end walls being overlapped and brazed at the corners as at 25 (Figure 3). The jacket extends downwardly of the cylinders approximately to the lower limit of piston travel and the bottom is formed by a panel 83 which is joined to the lower edges of the side and end walls 82 by means of the lapped, brazed seam 84. A series of openings defined by the vertical circular flanges 85 in the bottom panel encircle the cylinders 19. These joints are likewise secured by brazing 25.

Intake and outlet nipples 86 and 87 respectively communicate with the interior of the water jacket serving to supply water or other coolant to the engine, the intake nipple being located at a low point for increased cooling efficiency. These nipples are connected to the cooling system of the engine in the usual manner by suitable lengths of hose. Each nipple includes a bead 88 serving as an abutment or stop, the inner end of the nipple being crimped and clinched in place as at 89 after which the parts are brazed together. In order to aid in distibuting the coolant uniformly, the water jacket includes a longitudinal outwardly expanded corrugation 90 preferably semi-circular in cross section communicating centrally of its length with the intake nipple 86. The corrugation flares outwardly from its opposite ends, thus providing an enlarged passageway relative to the cylinders to facilitate the flow of coolant.

In respect to the distribution of water through the jacket, to insure uniformity of cooling, attention is invited to my co-pending patent application, Serial Number 666,455, filed May 1, 1946, entitled Cooling system for internal combustion engines, now Patent No. 2,456,951, in which a baffle plate is disclosed containing metering apertures for regulating the amount of water delivered from the inlet to each cylinder area.

As shown in Figures 3 and 6, one side wall of the water jacket is provided with a series of recesses or depressions 91, each accommodating a spark plug 92, as shown in broken lines on Figure 6. The spark plug is in screw threaded engagement within a screw threaded bushing 93 secured in an opening in the cylinder head. The spark plugs preferably are disposed at an angle with respect to the side wall of the water jacket. Therefore, bushings 93 are mounted in an angular boss 94 formed in the top of the cylinder head 20. The bushings are secured to the respective cylinder heads by upsetting or crimping the inner ends thereof, thereby forming shoulders 95 engaging the interior surface of the

cylinder head. The recessed portions 91 of the water jacket include flange portions 96 integral therewith encircling the exteriors of the bushings 93. Each bushing is further provided with an exterior flange 97 providing a shoulder with which the sheet metal flange 96 of the water jacket is engaged. Thus, the flange 96 serves to space the interior surface of the water jacket from the cylinder head. At the same time, the flange 96 and the head are in compressed engagement with one another between the flanges 93 and 95 of the spark plug bushing. After the parts are brazed together a very strong joint is provided between these thin walled metal pieces. The arrangement permits cooling water to flow freely around the entire spark plug bushing thereby providing an effective cooling system for the tip of the plug at which the heat is most pronounced. The assembled parts are thereafter joined by brazing 25 to provide a gas pressure-tight seal with respect to the cylinder head and bushing and a fluid-tight seal between the bushing and water jacket.

The crankcase generally indicated at 12 upon which the cylinder block assembly is mounted, comprises in cross-section a semi-circular die casting, preferably of aluminum alloy. Longitudinal and transverse ribs stiffen and rigidify the structure. The casting also includes a rectangular flanged opening 98 communicating with the lower open ends of the cylinders. The upper surface 100 of this flange is faced or machined to receive a gasket 101 disposed between the flange and the base plate 13, the base plate likewise being preferably faced or machined, thereby effecting a fluid tight seal between the two surfaces.

The crankcase includes a series of transverse webs or ribs 102 disposed between the cylinders of the cylinder block. These webs are preferably four in number, one for each cylinder, and include semi-circular flanged bearing recesses 103 formed therein. These flanged recesses provide receptacles for suitable bearing liners indicated at 104, Figure 6. A lower bearing cap 105 is provided, one for each of the ribs, the caps being secured in place by the nuts 16 in screw threaded engagement in the studs 14.

Transverse webs 102 include thickened sections 106 which preferably are circular in cross section disposed in pairs straddling the bearing bosses 103. The portions 106 provide sufficient metal thickness to accommodate holes tapped and drilled therethrough to receive the studs 14. These studs further include integral hexagonal nuts 107 formed thereon which are disposed below the surface of the base plate 13 in cut-out portions 108 of the webs.

In assembly of the engine, the studs 14 may be screw-threaded and tightened in place through the webs 102. The fabricated and machined cylinder block then is positioned upon the crankcase by projection of the studs through the aligned holes of the base plate 13, after which the nuts 15 are applied to the studs and are tightened. After assembly of the crank shaft, the nuts 16 are threaded on the lower end of the studs to fasten the lower bearing caps 105 in position. This arrangement permits the removal of the bearing caps without disturbing the cylinder block since the studs 14 are in screw threaded engagement in the crankcase and the nuts 15 hold the parts in assembly.

Although the studs are screw threaded in the webs 102, the forces in tension set up in engine

operation are not transmitted to the block, but are transmitted through the studs to the bearing cap 105 as previously described. The shanks of the studs are engaged in the webs for assembly purposes and convenience in removing the crank shaft and the bearings, or for repairs, without dismantling the cylinder block from the crankcase.

It will be noted in Figures 6 and 10 that the upper edge of the webs 102 which are located between adjacent cylinders, serves as a support for the base plate in this area. Thus, each cylinder is individually supported upon a rigid integral box-like structure formed by the transverse webs and the longitudinal sides of the crankcase.

The crankcase is provided with a pair of longitudinal ribs 111 one on each side thereof. These ribs strengthen the crankcase longitudinally inasmuch as the crankcase serves as a mounting base for the entire assembly and is subjected to longitudinal forces due to the engine weight and to shocks which may occur when the engine is installed in an automobile.

The engine is mounted preferably by means of mounting lugs 112, cast integrally with the crankcase and located at the forward end of the casting. As installed in an automobile the engine mounting and drive arrangement may follow that disclosed in the patent to Powell Crosby, Jr., No. 2,253,479. This arrangement essentially consists of a rigid connection between the rear wheels and the engine, universal joints being eliminated, by permitting the engine to pivot slightly. The thrust is transmitted through a rigid tube secured at its forward end to the engine and transmission assembly and at its rearward end to the differential housing, the propeller shaft being enclosed in this tube.

The crankcase is rigidly trussed by means of the transverse ribs 102 which reenforce it against torsional forces developed in the operation of the engine and against the thrust of the rear wheels by means of the longitudinal ribs 111. Since the engine assembly is mounted upon the crankcase and the crankcase in turn is mounted upon the frame of a vehicle or other foundation, the resistance to the torque force of the crank shaft will react in an equal torque transmitted to the crankcase through the base plate 13. This force is resisted by the lugs 112 which are anchored securely and is thus absorbed by the crankcase.

The present design and organization of parts results in very substantial advantages with reference to engine performance and likewise with reference to fabrication and assembly of the parts. In connection with the latter, it will be noted that all of the parts fit snugly one within another and that stops or abutments are provided for all such parts to position them correctly with respect to each other upon being pressed home. The advantage of this arrangement is two-fold. First, it eliminates the need for jigs and fixtures to hold the parts properly located in assembly for brazing and thus effects a savings in time and expense. With the exception of the assembly of the cylinder barrels, cylinder heads and base plate which may be joined by a heavy pressure fit, the design of the remaining parts makes them capable of being pressed together by hand, preferably by the use of a simple arbor press. Those parts which are clinched together are assembled preferably by means of a hand operated tool designed for this purpose. The parts automatically locate themselves correctly upon being pressed home, due to the stops or shoulders provided for this purpose. To expedite assembly, the various parts are preferably dimensioned to make a light press fit for hand assembly and the simplicity of design permits this work to be done by relatively unskilled operators. The parts fit together with sufficient tightness to hold together by friction prior to being brazed. Second, a strong mechanical bond between the parts is insured when they are brazed because the arrangement provides contacting surfaces, with only narrow crevices within which brazing material is free to flow by capillarity. This results in an exceptionally strong union between the parts and likewise produces pressure-tight seals.

In preparing the assembly for brazing, brazing material, either in wire or paste form, is applied at the various joints required to be brazed. Since most of the parts are of cylindrical form, a wire is simply wound about the part at the joint and upon reaching the fusing temperature in the furnace the material flows into the joint by the combined action of gravity and capillary attraction. In instances where the brazing wire is necessarily applied beneath the joint, it may be secured in place by the application of a copper paste. In such instances the material flows upwardly by capillary attraction into the joint.

In order to expedite the mechanical assembly of the parts the lower and upper sections, 17 and 18 respectively, may be assembled separately, the assembled units being joined together at the time of firing in the brazing furnace. Whether or not the units are assembled independently, it is preferable that the entire cylinder block assembly be brazed simultaneously, thus achieving a relatively uniform braze throughout the assembly.

Although the valve bonnets are formed of relatively light gauge sheet metal stampings, a high degree of strength and rigidity is imparted to them as a result of their formation. This is particularly true with respect to the intake bonnets which form arches as viewed in Figure 1, the combined effect of the intake and exhaust bonnets providing a truss-like structure spanning the tops of the cylinder heads and the top of the water jacket and securing the tops of the cylinders together. This also rigidifies and strengthens the water jacket which derives its primary support at the top and also provides a solid support for the upper valve casing 17 mounted on the top of the jacket.

Following the fabrication and brazing of the engine block assembly, it is preferable first to machine the bottom face of the base plate, by surface grinding or the like, in order that this face may be used as a reference plane from which dimensions may be established in later machining operations. If the cylinder heads are not spaced uniformly from the lower surface of the base plate, the pistons will travel to different levels within the cylinders and the gases within the cylinders will not be compressed uniformly, from cylinder to cylinder; this may cause uneven power delivery, and also cause vibration. In the present construction the individual cylinder tubes may be cut substantially to finish length from tube stock without regard to precise dimensions in the cut-off operation. However, the desired exact spacing of the cylinder heads from the base plate surface is obtained by providing

shoulders through counterturning or counterboring to limit the engagement of the cylinder tubes with the base plate, and the engagement of the cylinder heads with the cylinder tubes. These shoulders, as shown in the drawings, may readily be spaced apart from one another precisely and uniformly. In this manner the need for great care in assembling operations is eliminated inasmuch as it is convenient to bring the parts together until the shoulders are engaged.

The cylinders, valve seats, valve stem guides and upper valve guide sleeves are formed of machine steel. After being brazed, these parts are rigidly integrated in the assembly and their relationship with each other is fixed. The rigidity of the structure compares very favorably with a cast cylinder block of similar proportions. Therefore, these parts which require to be finished accurately as to diameter and which require proper alignment with each other, are machine finished in assembly, the valve guides and seats being line reamed and ground according to standard practices. The cylinders likewise are machine finished to close dimensional tolerances according to the standard commercial practice such as by grinding and lapping. The cylinder block therefore is accurately finished to provide the required running fits for the moving parts of the machine. An advantage over cast engine block construction lies in the fact that the cylinders and guides are formed from selected alloy steels best adapted to the particular usage and free of impurities and imperfections frequently encountered in castings, and present hardened wear resistant surfaces.

The thin-walled steel cylinder barrel, having its lower end pressure fitted into the base plate and its upper end closed by a thin wall stamped steel cylinder head, pressure fitted thereon, constitutes a primary structural element of the engine upon which is directly imposed the maximum combustion pressures developed in engine operation.

Attempts in the past to directly and permanently braze the heads to the cylinders and eliminate the use of gaskets have resulted in failures due to weakness in the joint, at time permitting the head to blow off under maximum cylinder pressures.

To remedy this situation, designers have resorted to the expedient of attaching the heads by spot-welding or screw threading them on the cylinders, then sealing the joint by brazing. This proved to be unsatisfactory because the seal tends to be interrupted circumferentially due to the spot welds, and in the instance of the threaded engagement, by the irregular brazing surface presented by the screw threads. Furthermore, the screw threaded construction results in a relatively heavy metal section where the screw threaded flange of the head overlies the top of the cylinder, thus impeding the flow of heat from the combustion chamber.

In the present instance the head and base plate are directly joined to the cylinder barrel either by a shrinkage fit or by a heavy press fit. If by shrinkage fit a temperature differential is employed either by lowering the temperature of the barrel to contract it, or by raising the temperature of the head and base plate to expand them. An appropriate differential between the dimensions of the mating parts develops a relatively high pressure between them upon assembly, binding the parts firmly together when permitted to reach normal temperatures.

When the parts are joined by a press fit a metal-to-metal interference is created, the shouldered opposite end portions of the barrel being approximately .001" larger than the mating inside diameters of the head and base plate openings. The parts are pressed together under high pressure to join the head and base plate firmly to the cylinder barrel.

After pressure fitting of the parts, the cylinder assembly is brazed by the application of a brazing wire about the barrel respectively at the juncture of the head and base plate. Although the joints are pressure fitted, the brazing material, upon fusing, penetrates between the adjoining pressure gripped surfaces of the joint in the form of a minutely thin film. It has been observed upon examination that this film extends for the full length and circumference of the joints, permanently uniting the parts, sealing the joints and integrating the structure. It will be apparent the use of gaskets between the cylinder head is eliminated.

As shown in broken lines on Figure 6, the upper limit of piston travel, which defines the combustion chamber, is in the area of the pressure fitted flange of the cylinder head, at the top of the cylinder. It will be apparent, therefore, that during operation, the flow of heat from the combustion chamber will tend to raise the temperature of the cylinder above that of the head flange, the cylinder being exposed to the burning gases in the combustion chamber while the flange of the head is exposed exteriorly to the coolant in the water jacket. This temperature differential therefore tends to expand the cylinder with respect to the head tending to increase the gripping pressure of the brazed joint.

After having been brazed, the interior surface of the cylinder barrel is machined truly circular and finished to receive the piston and provide a seal with the piston rings. The wall thickness of the cylinder barrel, after machining, is at least $\frac{1}{16}$" at all points but need not be in excess of $\frac{3}{32}$".

The exterior surface of the upper portion of the cylinder barrel and cylinder head, in which the maximum combustion temperatures are developed, are directly exposed to the coolant in the water jacket. These parts, being of thin walled construction, cause an exceedingly rapid dissipation of heat in this critical area, whereby the efficiency and potential output of the engine is materially increased.

Having described my invention, I claim:

1. A cylinder block for an internal combustion engine comprising a series of seamless metal tubes, the axes of which are disposed parallel to one another and in the same plane, a metal plate adapted to be attached to a crankcase, said metal plate being apertured so that the lower end of each cylinder tube is disposed in an aperture in said plate, closures for the tops of said tubes, and intake and exhaust manifolds fabricated from sheet metal, said manifolds connecting and cross bracing each cylinder and a sheet metal member connecting said manifolds at their tops to form a truss-like structure which secures said tubular cylinders together at their upper ends.

2. In an internal combustion engine, the combination of a cylinder block and a crankcase, the cylinder block comprising a plurality of hardenable alloy steel tubes constituting the cylinders, the tubes held together at their upper ends by sheet metal intake and exhaust manifolds, their lower ends held together by a thin sheet metal

plate having apertures into which the respective ends of the cylinders are press-fitted and brazed, the crankcase consisting of an aluminum casting having transverse webs extending from side to side; one web on each side of each cylinder with bearings disposed in the webs and a series of bolts, two passing from the lower halves of each crankshaft bearing through the webs and through the plate which holds the tubular cylinder in assembly at their lower ends, thus, connecting the cylinder block and crankcase and providing four bolts about the periphery of each cylinder, directly attaching the bearings on each side of the cylinder directly to it, to contain the explosive pressure of each cylinder individually as it fires.

3. In an internal combustion engine, a cylinder block unit providing cylinders, a rigid plate supporting the lower ends of the cylinders and having for this purpose apertures therein in which the lower ends of the cylinders are secured, said block unit further including gas intake and discharge conduits fixed to the tops of the cylinders, a water jacket surrounding the cylinders and conduits and including a top wall, and a valve guide unit secured along and upon said wall, said valve guide unit being of rectangular casing form and including valve guide sleeves and cross ribs.

4. In an internal combustion engine, a cylinder block unit including cylinders, a web of metal thickness greater than that of the cylinder walls, including apertures in which the lower ends of the cylinders are engaged, a reenforcing structure disposed along the top of the row of cylinders, said structure being rigid and incorporating valve guides and manifolds in cross-arched relationship with the respective cylinders, the upper structure constituting a structural beam stiffening the cylinder block and maintaining the cylinders against displacement.

5. A cylinder block and crank case assembly for an internal combustion engine comprising: a plurality of cylinder tubes, a base plate the lower end of each of said tubes respectively secured to the base plate, and the upper ends of the tubes respectively having individual cylinder heads secured thereon, a longitudinally trussed, box-like unit disposed at the tops of the cylinder tubes, said unit providing a valve casing for housing the valve actuating mechanism, the cylinder heads being united to said valve casing by a plurality of valve bonnets extending between the cylinder heads and the valve casing; an independent, longitudinally trussed box-like unit disposed at the bottoms of the cylinders beneath said base plate and forming a crankcase including longitudinal reinforcing ribs formed on the top portion thereof and transverse reinforcing ribs, the base plate being mounted upon and secured to the crankcase.

6. A cylinder block and crankcase assembly for an internal combustion engine comprising: a pair of upper and lower spaced parallel trussed units and a plurality of individual cylinder tubes disposed laterally therebetween, each of said cylinder tubes having an individual cylinder head secured upon its upper end, a base plate common to the lower ends of the cylinder tubes the upper of said trussed units providing a valve casing for housing valve actuating mechanism, said cylinder heads being united to said valve casing, the lower of said trussed units providing a crankcase for the engine and having longitudinal reinforcing ribs formed on the top portion thereof and transverse reinforcing ribs, the crankcase being secured to said cylinder block base plate by means of bolts engaged in said transverse ribs.

7. A cylinder block assembly comprising: a series of drawn cylinder tubes, a sheet metal base plate, said base plate being apertured and having the lower end of each cylinder tube pressed in respective aperture, thereof, a plurality of sheet metal closures for the tops of said tubes, said closures being pressed on the respective tubes and including respective intake and exhaust ports, and sheet metal intake and exhaust bonnets, said bonnets being pressed into said ports respectively, said cylinder tubes, base plate, closures, and bonnets being brazed together.

8. In an internal combustion engine, a plate in the form of a sheet like member having a plurality of bores in a line, a plurality of thin-walled seamless metal cylinder tubes having the respective endwise portions thereof press fitted into the bores of the plate and brazed thereto, the areas in brazed contact between the cylinders and the plate bores being of such extent that the brazing material is capable of resisting the shearing actions exerted thereon during engine operation.

9. A cylinder block construction comprising, a flat sheet of metal of substantial thickness forming a base plate having a series of aligned apertures therein, seamless thin wall metal tubes, forming cylinders, having endwise portions thereof press-fitted and brazed in said apertures so as to project laterally from said base plate in substantial parallel relationship to one another, cylinder heads press-fitted and brazed to the opposite ends of said cylinder tubes, and sheet metal conduit members in the form of arches rigidly connecting the heads of adjacent cylinders one to another, whereby each cylinder supports each adjacent cylinder against independent movement.

10. A block for an internal combustion engine, comprising a plurality of thin wall, seamless metal tubes constituting cylinders, heads attached to the tops of said cylinders, intake conduits in the form of arches spanning adjacent cylinders and connected to the heads thereof, and exhaust conduits in the form of right angle elements disposed laterally with respect to said arches, one for each cylinder and extending from the head thereof, the said arched intake conduits having lateral nipples extending substantially parallel with said exhaust manifolds, the free ends of said exhaust manifolds and nipples being connected in common to a rigid plate, and a base plate which is common to the lower ends of said cylinder tubes and which is rigidly fastened thereto.

11. In an engine block for an internal combustion engine, at least a pair of cylinder tubes of seamless thin wall metal, a plate interconnecting the exterior peripheries of said tubes at one end thereof, said tubes having heads at the opposite ends thereof, an arch shaped conduit having its endwise portions respectively connected to said heads, and conduits in the form of elbows extending from said heads adjacent said arch conduit in directions lateral to said arch conduit.

12. In an engine block for internal combustion engines, at least a pair of cylinder tubes of seamless thin wall metal, a plate interconnecting the exterior peripheries of said tubes at one end thereof, said tubes having heads at the opposite ends thereof, an arch shaped conduit having its endwise portions respectively connected to said heads, and conduits in the form of elbows ex-

tending from said heads adjacent said arch conduit in directions lateral to said arch conduit, said elbows and said arch conduit having projections respectively aligned with said cylinders forming valve guide seats.

13. An engine block for internal combustion engines, comprising at least a pair of cylinder tubes of seamless thin wall metal, a plate interconnecting the exterior peripheries of said tubes at one end thereof, said tubes having heads at the opposite ends thereof, an arch shaped conduit having its endwise portions respectively connected to said heads, conduits in the form of elbows extending from said heads, adjacent said arch conduit, in directions lateral to said arch conduit, said elbows and said arch conduit having projections respectively aligned with said cylinders and forming valve guide seats, and a box above said cylinder heads adapted to contain valve actuating mechanism, said box having a bottom wall fastened to said projections.

14. A construction for an engine block fabricated from sheet metal, which comprises a plate of substantial thickness having an aperture therein, a cylinder having a counterturned portion defining a shoulder at one end thereof, the said counterturned portion being adapted to form a press fit with said aperture, and the said shoulder being spaced from the end of said cylinder a distance corresponding substantially to the thickness of said plate for engagement with the surface of said plate, and a cylinder head for the opposite end of said cylinder, the said cylinder end and head being configurated relative to one another to present a second shoulder spaced from the first shoulder a predetermined distance whereby the combustion space within the cylinder, by spacing of said shoulders, is fixed at a predetermined distance from the lower face of said plate.

15. A cylinder block for an internal combustion engine, comprising an assembly of thin wall metal elements, including seamless tubes, constituting cylinders, stamped sheet metal heads and a sheet metal base plate having apertures therein in spaced alignment for receiving endwise portions of the cylinder tubes in press-fitted relationship, the cylinder heads and the cylinder tubes having respective machined surfaces forming press fits one with another, arch-shaped conduits constituting intake passageways rigidly joining the heads of adjacent cylinders, and elbow-shaped conduits forming exhaust passageways extending laterally in respect to said arch-shaped intake conduits, said intake conduits having sidewise openings, a rigid manifold plate to which the free ends of said elbow-shaped conduits are connected, and means for connecting the sidewise openings in said arch conduits to said manifold intermediate the elbow-shaped conduits.

16. The combination, in an internal combustion engine, of a cylinder tube, a cylinder head having a spark plug aperture, a water jacket surrounding the cylinder tube, projecting above the cylinder head and having an inwardly flanged aperture aligned with said spark plug aperture in the head, and a thin wall bushing, threaded internally to receive a spark plug, said bushing being disposed within said aligned apertures having lateral flanges at its endwise portions respectively engaging the interior surface of said head and the exterior surface of said water jacket, said water jacket being spaced from said head by means of said inturned flange.

17. The combination of a cylinder head having a spark plug aperture, a water jacket surrounding the head in spaced relationship thereto, said water jacket having an aperture aligned with the aperture in said head, and a bushing disposed within said aligned apertures, said bushing being a thin wall member threaded internally to receive a spark plug and having lateral flanges at its opposite ends respectively engaging the interior surface of said head and the exterior surface of said water jacket, said water jacket, bushing and head being brazed together in fluid and pressure-tight connection with one another.

18. In an internal combustion engine, a plate in the form of a sheet like member having a plurality of bores in a line, a plurality of thin-walled seamless metal cylinder tubes having the respective endwise portions thereof press fitted into the bores of the plate and brazed thereto, the areas in brazed contact between the cylinders and the plate bores being of such extent that the brazing material is capable of resisting the shearing actions exerted thereon during engine operation, the bottom face of the plate of smooth planar reference surface and the inner surfaces of the cylinders being true and at right angles thereto, and means including a truss-like upper structure for holding said cylinders to said plate as they are fired.

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ENGINE

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Fig. 1

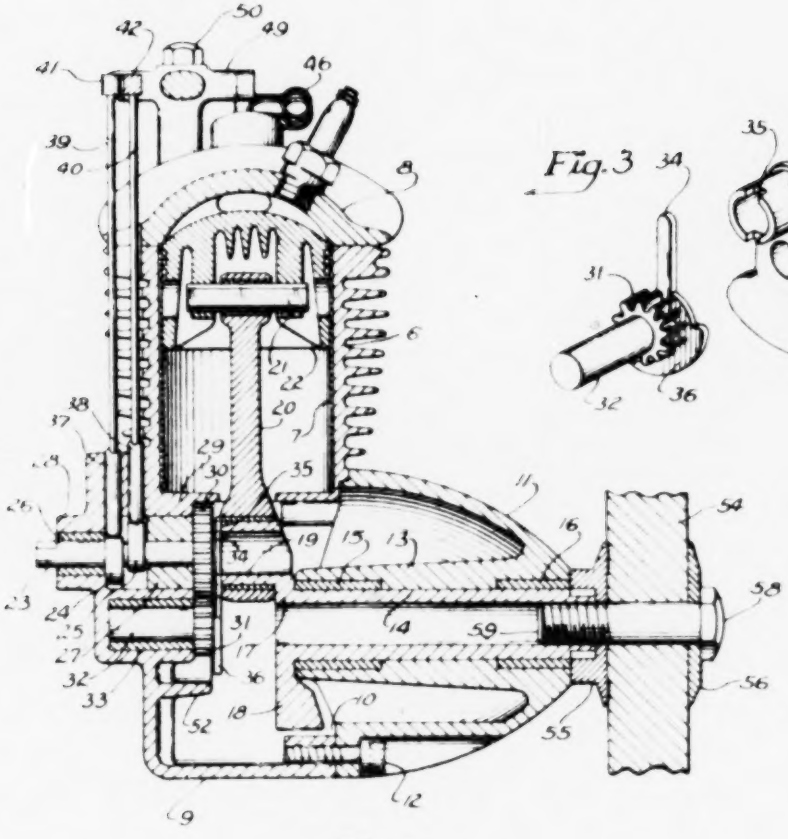


Fig. 2

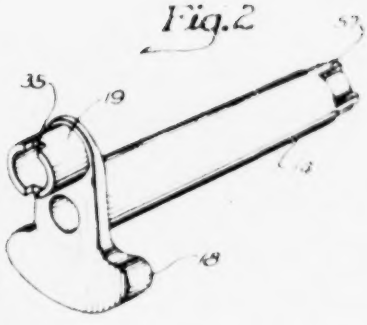


Fig. 3

Fig. 4

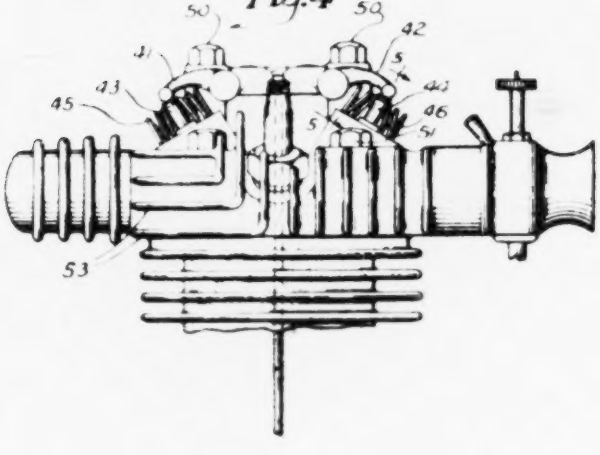
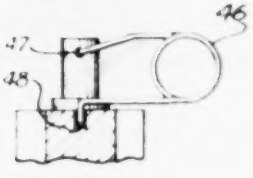


Fig. 5



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Patented July 3, 1951 2,559,079

UNITED STATES PATENT OFFICE

2,559,079

ENGINE

Casimir E. Leja, Chicago, Ill.

Application October 15, 1947, Serial No. 780,049

4 Claims. (Cl. 123—84)

1

This invention relates to internal combustion engines and is particularly directed to small engines of this type which are adapted for various uses and particularly for aviation and racing cars or models.

The principal object of the invention is to provide an improved engine of this type which will be simple in construction, easily started and durable and efficient in operation.

Other objects are to provide an improved engine housing; to provide a simplified crankshaft and improved camshaft drive; to provide an improved mounting for a propeller or fly wheel; to provide novel valve springs; and to provide such other improvements in construction and operation as will appear more fully from the following description.

In the accompanying drawing illustrating this invention,

Fig. 1 is a longitudinal sectional view with parts broken away or omitted for convenience in illustration;

Fig. 2 is a perspective view of the crankshaft;

Fig. 3 is a perspective view of the camshaft and driving mechanism;

Fig. 4 is a front view as taken from the right hand side of Fig. 1 particularly showing the improved cooling fins; and

Fig. 5 is a detail of the valve spring mounting.

As shown in these drawings, 6 is the cylinder which is preferably provided with a steel lining 7 and cylinder head 8. The crankcase 9 is cast integrally with the cylinder and has an opening 10 which is concentric with the shaft and which is covered by a housing 11 secured thereto by means of cap screws 12 as shown. The housing 11 is of somewhat oval or egg-shape and is provided with an inwardly extending elongated bearing 13 for the tubular crankshaft 14. Bushings 15 and 16 are pressed into the ends of the bearing member 13 for engagement with the crankshaft. The crank arm 17 has a counter weight 18 at one end and a tubular crank pin 19 at the opposite end. The crank pin is engaged by one end of the connecting rod 20. The opposite end of the connecting rod engages with the wrist pin 21 of the piston 22.

The camshaft 23 is formed integrally with the cams 24 and 25 and is held in place by split bearings 26 and 27 which are first assembled on the camshaft and then pressed into bosses 28 and 29 provided in the crankcase for receiving the same.

The camshaft 23 has a gear 30 secured to its inner end which meshes with a pinion gear 31

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formed integrally with a stub shaft 32 which is mounted in a bearing 33 in alignment with the axis of the shaft 13. The stub shaft 32 has a radially extending arm 34 which is also preferably formed integrally with the gear 31 and engages with a slot 35 in the end of the crank pin 19 as shown in Figs. 2 and 3. The arm 34 has a counter weight 36. By means of this gearing arrangement, the camshaft will be driven at the proper speed and it will be particularly noted that the pinion 31 will remain in the crankcase and the proper timing will be maintained when the crank pin engages with the arm 34. This arrangement provides for the convenient removal of the crank and again assembling the same without disturbing the valve timing.

The cams 24 and 25 engage respectively with cam followers 37 and 38 which actuate the push rods 39 and 40 for operating the rocker arms 41 and 42 which coact with the valve stems 43 and 44 in the usual manner.

The valve stems are raised by springs 45 and 46, the particular construction and arrangement of which constitutes one of the important features of the present invention. These springs are of the hairpin type with their central portions extending through holes 47 in the ends of the valve stems. The coil portions of the springs are positioned on either side of the valve stem and their terminal portions 48 engage with holes in the upper surface of the cylinder head as shown in Fig. 5. The downwardly projecting portions 48 are of sufficient length so that the ends thereof bear against the bottoms of the holes and provide the only points of contact between the springs and the cylinder head. The arrangement is such that the bearing portions of the springs will be in alignment with the center line of the valve stems and thus tend to prevent any lateral pressure on the upper portions of such stems when the valves are operated.

This type of floating spring has a higher period of vibration or oscillation than an ordinary coiled spring and does not tend to surge as readily as such springs. The rocker arms are pivotally mounted in a housing or bracket 49 which is secured by means of two studs 50 which studs also serve to fasten the cylinder head to the cylinder. The cylinder head is further fastened by two similar shorter studs 51. This arrangement adds to the saving in weight and simplicity of construction.

A substantially circular guard or protector 52 which is concentric with the axis of the crankshaft is cast at the rear of the crankcase and ex-

tends inwardly over the camshaft gears. This guard prevents damage to the connecting rod when the propeller or fly wheel is removed and the engine is cranked, or also in the event of certain kinds of accidents or "crack-ups."

Some of the cylinder head cooling fins such as shown at 53 are arranged to curve from a horizontal plane to a vertical plane, thereby giving more fin area on the exhaust side of the cylinder head as shown in Fig. 4. This particular arrangement adds greatly in maintaining the proper temperature of the engine for giving the highest efficiency.

The driven member 54 which may be a propeller, fly wheel, pulley, or the like, is mounted between two discs 55 and 56. The disc 55 is secured to the shaft 14 preferably by means of splines or projections 57 which fit in corresponding grooves in the hub of the disc. A cap screw or bolt 58 extends through the discs and driven member and is threaded to engage with the corresponding threads 59 in the end of the crankshaft 14. This permits an easy and convenient mounting of the propeller, or the like, and in the event of damage, there is little possibility of injury to the crankshaft.

From this description, it will be seen that I provide an engine in which the crankshaft housing is such that it provides for ease of assembly in production, and furthermore increases the capacity of the crankcase. This lowers the crankcase compression and results in cleaner and more efficient running. The construction whereby the crankcase and cylinder are cast together with necessary bosses or projections or various operating parts further enhances the simplicity of construction and economy in the manufacture of the engine as well as improvement in the operation of the same.

It will be noted that the engine may be provided with any desired form of ignition and other coacting devices such as fuel supply, and the like, in order to make an operative structure, but such parts have not been described as they form no part of the invention except as instrumentalities used in the operation of the same.

It will also be noted that changes may be made in the details of construction or arrangement of the parts without departing from the spirit and scope of the invention, and therefore I do not wish to be limited to the particular construction shown and described except as set forth in the following claims in which I claim:

1. In an internal combustion engine, the combination of a cylinder, a crankcase, a crankcase housing extending outwardly from the crankcase and forming an extension therefor and having a bearing extending into the crankcase, a crankshaft mounted in said bearing, a piston in said cylinder, a piston rod connecting the piston with the crank, said crankshaft having its crank pin extending a short distance only through the piston rod and having a transverse slot therein, a stub shaft mounted in the crankcase in alignment with the crankshaft, a pinion on the stub shaft adjacent to the crank pin, an arm extending radially from the stub shaft and engaging with the slot in the crank pin, a camshaft mounted adjacent to the stub shaft and a gear on the camshaft engaging with the pinion on the stub shaft, the arrangement being such that the stub shaft and pinion may remain in the crankcase when the crankshaft is removed and the timing will be maintained when the crankshaft is inserted with the slot in the crank pin engaging with said arm.

2. Valve actuating means for an internal combustion four-cycle engine having a crankcase which is closed at one end, a bearing extending inwardly from the closed end and open to the crankcase, a stub shaft mounted in the bearing and extending into the case, a gearing on the inner end of the stub shaft formed integrally therewith, an arm formed integrally with the gear and extending at right angles thereto, the crankcase having an opening opposite the closed end, a housing covering said opening, a crankshaft bearing in the housing, a crankshaft mounted in said bearing and having a crank pin with a transverse slot in the end thereof which is engaged by said arm, a removable bearing in the closed end adjacent to the stub shaft bearing, a camshaft mounted in said bearing and extending into the crankcase, a gear on said camshaft which meshes with the first named gear, and cams formed integrally with the camshaft which are also positioned in the crankcase.

3. An engine having a crankcase which is closed at one end, a bearing in the closed end which opens into the crankcase, a stub shaft mounted in said bearing and extending into the case, a gearing carried by the stub shaft, an arm on the gearing extending radially therefrom, the crankcase having an opening opposite the closed end which is sufficiently large to permit the insertion of the stub shaft with the parts mounted thereon into position through said opening, a housing for said opening, a crankshaft bearing in the housing, a crankshaft mounted in the bearing and having a crank pin with a transverse slot in the end thereof which is engaged by said arm for turning the stub shaft, the arrangement being such that the stub shaft and parts connected therewith may be readily inserted through the opening and the housing with the crankshaft therein may be assembled to bring the arm in engagement with the crank pin.

4. An engine having a crankcase closed at one end, a bearing in the closed end, a stub shaft mounted in the bearing and extending into the case, a gear carried by said stub shaft, an arm extending radially from said gear, a bearing in the closed end adjacent to the bearing for the stub shaft, a cam shaft mounted in said bearing and extending into the crankcase, a gear on said cam shaft which meshes with the first named gear, and a substantially circular guard projecting from the crankcase wall and extending inwardly over said gears, substantially as described.

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Oct. 2, 1951 G. H DINGMAN 2,563,461

MAGNETO

Original Filed May 23, 1946 3 Sheets-Sheet 1

Fig. 1.

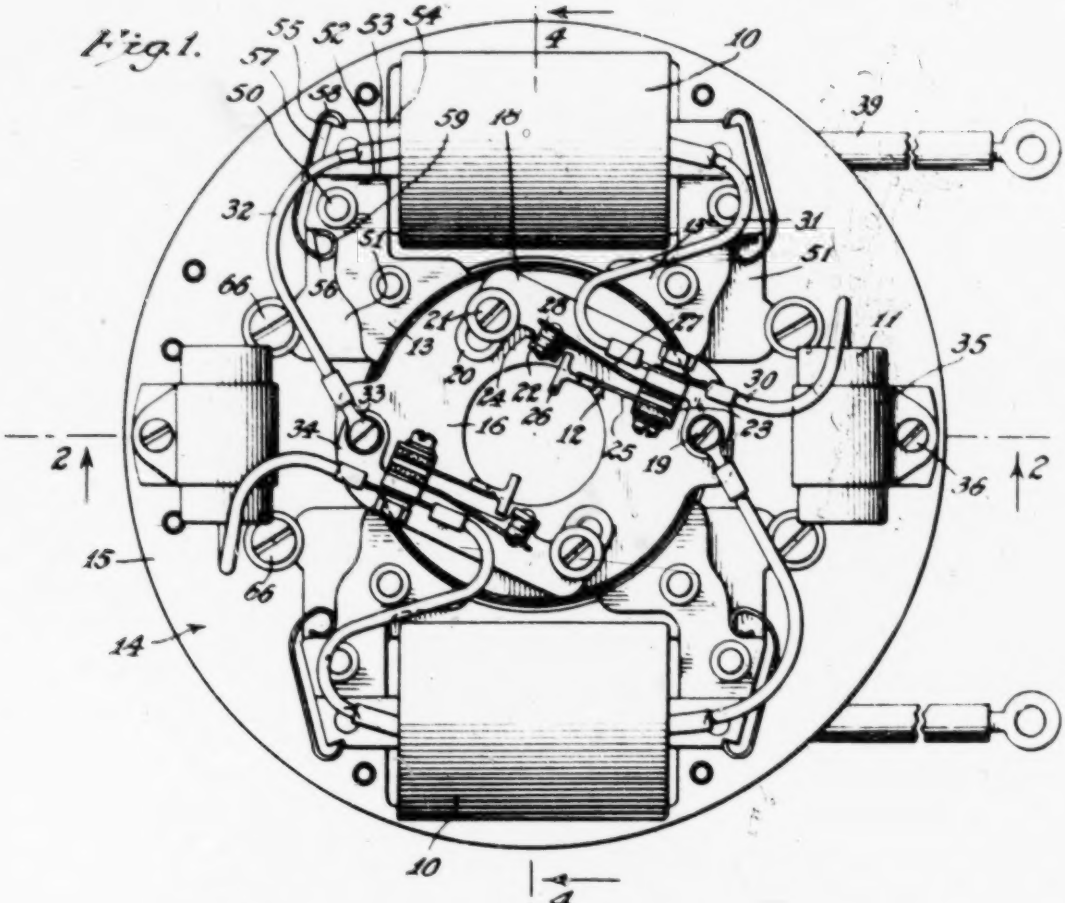
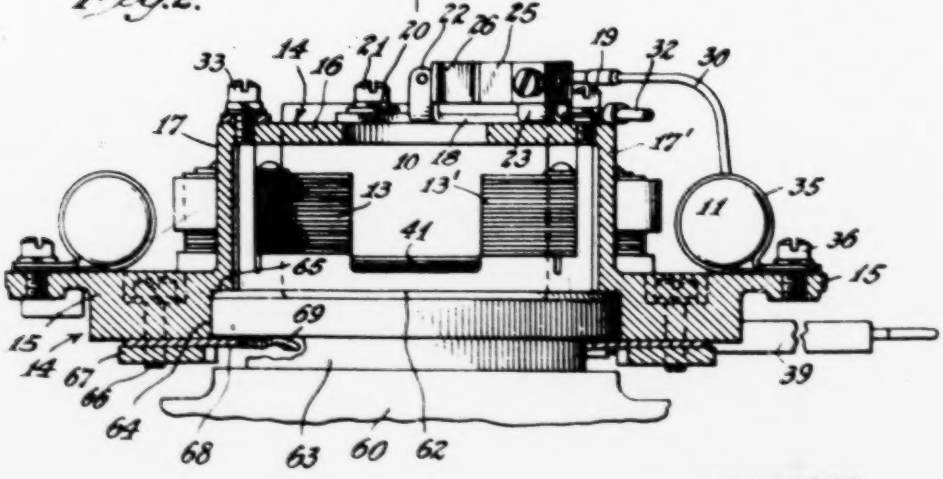


Fig. 2.



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MAGNETO

Original Filed May 23, 1946 3 Sheets-Sheet 2

Fig. 3.

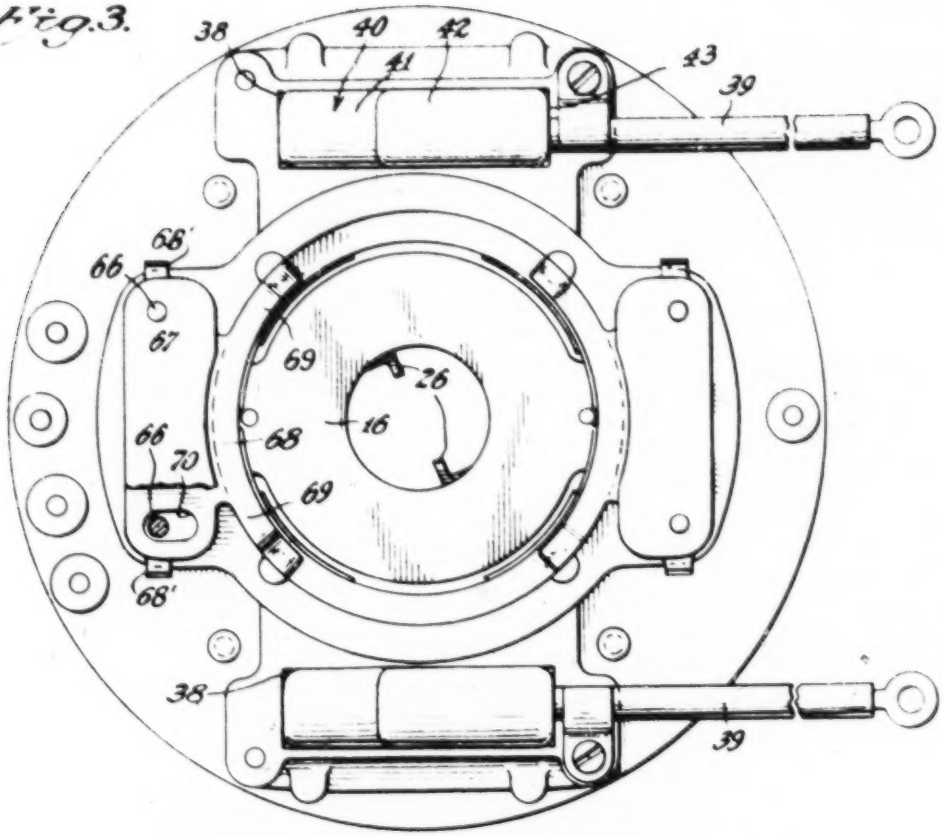
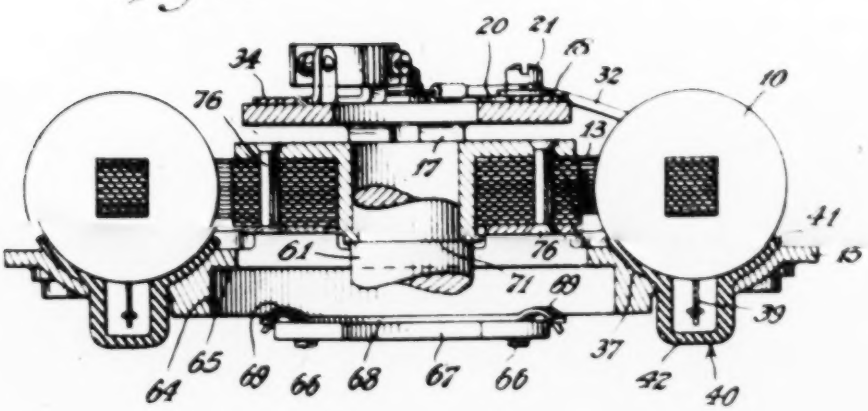


Fig. 4.



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MAGNETO

Original Filed May 23, 1946 3 Sheets-Sheet 3

Fig.5.

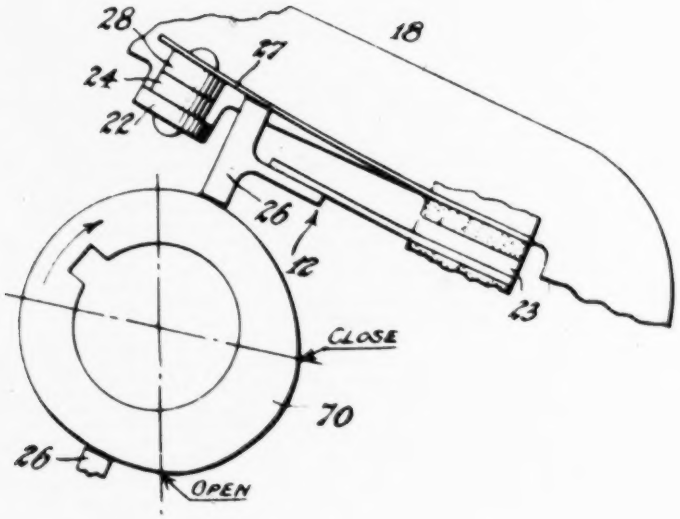


Fig.6.

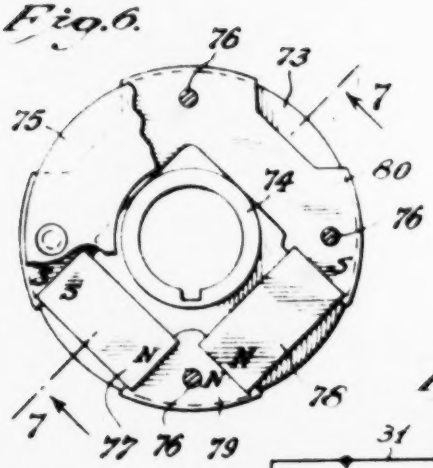


Fig.8.

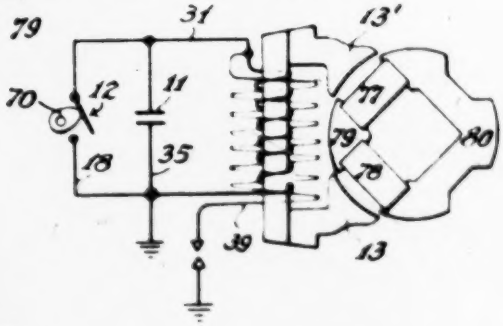
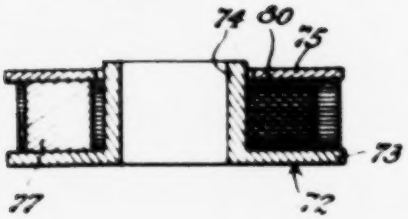


Fig.7.



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Patented Oct. 2, 1951 2,569,461

UNITED STATES PATENT OFFICE

2,569,461

MAGNETO

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Original application May 23, 1946, Serial No. 671,695. Divided and this application February 9, 1950, Serial No. 143,283

12 Claims. (Cl. 171—209)

1

This invention relates to magnetos and more particularly to the mechanical construction thereof and the mounting thereof on an engine casing or the like.

This application is a division of applicant's copending application Ser. No. 671,695 filed May 23, 1946, for Magneto.

One of the objects of the present invention is to provide a mounting for the parts of a magneto adapted to make the assembly of parts easy and efficient.

Another object of the invention is to provide novel means for mounting a magneto stator on an engine casing or the like whereby the magneto may be readily installed or removed from the casing and whereby adjustment of the magneto relative to the casing is greatly facilitated.

The above and further objects and novel features of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

Fig. 1 is a plan view of a flywheel or crankshaft type of magneto with the cam and shaft, and the rotor omitted;

Fig. 2 is a sectional view of the magneto stator taken on the line 2—2 of Fig. 1;

Fig. 3 is a bottom plan view of the structure shown in Fig. 1;

Fig. 4 is a section on the line 4—4 of Fig. 1;

Fig. 5 is a schematic detail plan view showing the cam and its operative relation to the breaker points located at diametrically opposite positions;

Fig. 6 is a bottom plan view of the rotor broken away to show concealed parts;

Fig. 7 is a section of same on the line 7—7 of Fig. 6; and

Fig. 8 is a diagram of the circuits.

Referring to the numerals of the drawings, and particularly to Fig. 1, a magneto transformer is indicated by the numeral 10, its associated condenser by the numeral 11, its associated circuit breaker by the numeral 12, and its stator pole shoes by the numerals 13, 13'. These operative parts of the magneto are duplicated, but the initial description will be limited to them since the operation of the duplicates is identical, occurring, in the construction shown, 180° later.

The frame 14 of the magneto comprises a casting, which may be of aluminum or any other satisfactory metal or material of sufficient strength and the requisite conductivity, having coaxial annuli 15, 16 of which the smaller has outer dimensions approximating the inner dimensions of the larger and is supported therefrom by integral flat posts 17, 17'.

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The smaller annulus 16 carries a metal arm 18 pivotally attached thereto by a screw 19 and having a slotted end 20 through which a set screw 21 passes, giving adjustability to the position of the arm and the breaker elements mounted thereupon. Two metal ears 22, 23 project upwardly from the body of the arm 18, the first of which serves as a support for breaker point 24 and the second of which serves as a support for spring 25 which carries on its end a T-shaped dielectric cam follower 26. The cam follower rides upon the cam carried by the shaft and is displaced by the lobe of the cam toward the spring breaker arm 27, which carries at its end a breaker point 28 which is normally in contact with breaker point 24, acting under the impulse provided by the cam to break the circuit through the points in the manner which will be understood by persons skilled in the art. The breaker arm 27 is electrically connected to the terminal of a cable 30 of the condenser 11 and to the terminal of a cable 31 that issues from the coil 10. The coil is grounded through the cable 32 affixed at its terminal to the screw 33 that attaches the supporting arm 34 of the other breaker to the frame or support 14. The condenser 11 is grounded and fastened to the frame by a strap 35 which encircles it and has its ends affixed to the plate 15 by a screw 36.

A mounting for the coil 10 is provided. As will be understood by persons skilled in the art, the coil has three leads, one to the primary, one to the secondary, and a joint lead to the ground. One of these leads is brought out, in the coil being described, through the circular wall of the coil and poses a problem of protection which has been cared for in a novel manner. A depressed and apertured seat 37 is provided, the curvature of which conforms to that of the coil. The depressed seat has two halves that are separated by an aperture or slot 38 that is seen from the bottom in Fig. 3. The shape of the seat provides end abutments which act to retain the coil against endwise displacement. A high tension lead 39 projects from the wall of the coil and is received in the aperture in the seat.

In order that the lead and the coil itself may be protected against damage from the metal of

the frame, from vibration, and from shock, a protective pad 40 is provided. That pad is preferably made from a flexible dielectric substance such as rubber having a flat or curved bed 41 that overlies the coil and conforms to the shape of the seat. A channel-shaped, depressed portion 42, having width about equal to the width of the aperture in the seat and length and depth sufficient to enclose the lead 39 is provided. An opening 43 is provided in the end of the channel-shaped portion 42, beneath the plate 15 through which the high tension lead is passed. The hole in the protective pad may be made to conform snugly to the lead so that vibration of the lead will not harmfully affect the connection to the coil.

The core of the coil is connected to the stator shoes of the magneto. Laminated stator shoes 13, 13' are bolted to the plate 15 by bolts such as 50 in such position that the curved portions thereof are in operative relation to the rotor of the magneto. Raised lands 51, formed integrally with the plate 15, serve to support the stator shoes. The shoes have flat ends 52 adapted to receive the flat sides 53 of the core 54 of the coil 10. Sharp notches 55 are provided in the upper ends of the core 54 and rounded notches 56 are provided in the sides of the stator shoes. Spring clamps 57 having sharp ends 58 and rounded ends 59 are adapted to clamp the ends of the core to the stator shoes in firm electrical connection while at the same time they maintain the coil in its seat in the plate 15. The rounded ends of the clamps are easily sprung into and out of position, but when in place form a firm connection that does not become accidentally disengaged.

The apparatus hereinabove described forms an interdependent novel combination with the casing 60 (Fig. 2) of the engine or other apparatus from which the drive shaft 61 (Fig. 4) projects. The machine or engine casing 60 has an annular flat top or end 62 and a groove 63 in the wall beneath the top thereby forming a pilot flange. The frame 14 is internally provided with a groove or recess 64, the upper face or end wall 65 of which serves as a shoulder to rest upon or against the end or outer radial wall 62 of the pilot flange of the casing. The annular or cylindrical wall of groove 64 has a diameter substantially equal to that of the pilot flange of the casing 60 and has a depth substantially equal to the distance between the end 62 and groove 63, i. e. the width of the pilot flange as illustrated particularly in Fig. 2. Bolts 66 are mounted in and project freely through the plate 15 and are screw threaded into plate 67 which serves as a nut. Between the plate or nut 67 and the body of plate 15 is an adjustable clamp 68 having circularly projecting spring arms or fingers 69 of curvature substantially conforming to that of groove 64. The arms or fingers 69 have offset cam ends to yieldably engage the inner radial surface of the pilot flange within groove 63. The body portions of the plates 68 have slots 70, as shown in Fig. 3, which permit it to be adjusted to move spring fingers 69 radially into and out of groove 63 for clamping engagement with the pilot flange of casing 60. Clamping plates 68 have outwardly bent tongues 68' at the upper and lower ends thereof, as viewed in Fig. 3, which project beyond the periphery of nut plate 67 and are accessible for facilitating radial movement of the clamping plate when the bolts 66 are not tightened. As many of these clamping plates may be provided as are necessary. Once they are adjusted to groove 63 in casing 60 and, hence, with relation to the pilot flange, they may be fixed into position by tightening the bolts 66, the heads of which are accessible from the upper or outer surface of plate 15.

The cam 70 is mounted on the end of the shaft 61, which projects through the annular plate 15 into operative relation to the circuit breakers. The single lobe of the cam is indicated by the words "Close" and "Open" in Fig. 5. This cam operates the two circuit breaker riders 26 alternately 180° apart so that the spark plugs served by the respective magneto units are fired alternately. By employing a cam of two lobes, the magneto can be made to fire the plugs simultaneously each 180° of arc.

The magneto rotor is seated upon the shaft 61 beneath the cam and in operative alignment with the stator shoes. The shaft 61 has a seat 71 upon which the rotor rests. Both the cam and the rotor are keyed to the shaft.

In Fig. 7, which is a section on the line 7—7 of Fig. 6, the numeral 72 indicates generally the frame of the rotor, which may conveniently be an aluminum casting having an annular plate 73 and a hub 74. The core pieces are laminated and are riveted to the plate 73 by means of brass cover plate 75 and rivets 76. Two magnets, 77 and 78, are arranged at 90° to each other, as indicated in Fig. 6, with their north poles in adjacent position. The north poles of the magnets are seated in appropriate grooves in laminated core piece or shoe 79 which is riveted to the plates 73 and 75. The other ends of the magnets are similarly seated in V-shaped core piece 80, mid-portions of which are cut out to provide three shoes. The middle shoe is substantially inactive so that there are provided by this arrangement a single north and two operative south poles, all of which are located within an arc of 180°. This produces a complete reversal of flux in the coil core once in each revolution of the rotor.

A wiring diagram for single circuit is illustrated in Fig. 8, it being understood that a similar wiring diagram would be provided for the second magneto circuit. No attempt has been made in this diagram to time the cam with relation to the position of the magnets, the particular arrangement being chosen for clarity of representation rather than for operative accuracy. In this figure is shown the rotor with the top plate 75 removed and the cam and breaker displaced to the extremity of the diagram. The ends of the primary and secondary of the coil are connected to the circuit breaker 12 and to the condenser 11, both of which are grounded. The other end of the primary is connected to ground, and the other end of the secondary is connected to a spark plug, which is grounded on the other side of the gap. When the leading end of shoe 80 becomes aligned with the second stator shoe, the shoe 79 is aligned with the first stator shoe and flux passes through the core in one direction. When the shoe 79 reaches the second stator shoe, the following end of shoe 80 reaches the first stator shoe and direction of the flux through the core is reversed. The cam is set on the shaft to make the most efficient use of this arrangement. Adjustment can be made by pivoting the arms 18 to new positions. Additional adjustments can be made by moving the frame 14 clockwise and counter-clockwise on the casing 60.

A particular advantage of this invention is in the construction of the supporting frame and in

the means for adjustably supporting it upon the casing of the machine.

Another advantage of the invention is in the novel means of mounting the several parts of the magneto upon each other and upon the frame.

Although only one embodiment of the present invention has herein been illustrated and described, it is to be expressly understood that the same is not limited thereto. Various changes may be made in the design and arrangement of the parts illustrated and in the materials used without departing from the spirit and scope of the invention, as will now be apparent to those skilled in the art. For a definition of the limits of the invention, reference is had primarily to the appended claims.

What is claimed is:

1. A connection comprising an annular body having an annular groove in the curved side beneath the end, a frame having a portion adapted to rest upon the annular body, a plate attached to the frame in proximity to the annular body having circularly projecting arms with offset, cam-like ends adapted to enter said groove, and means to adjust said plate and to fix it in adjusted position.

2. A stator for a magneto comprising a frame having an annular recess for receiving a circular pilot flange on a support, said flange having inner and outer radial surfaces, and means for securing said frame against axial movement relative to said flange and for frictionally holding the same against relative angular movement, said means including a plurality of plates having spring fingers extending therefrom for frictional engagement with the inner radial surface of said flange and screws and nuts clamping said plates to said frame.

3. Apparatus as defined in claim 2 wherein each screw extends freely through the frame and plate for threaded engagement with a nut.

4. Apparatus as defined in claim 3 wherein the heads of the screws are accessible from the side of the frame opposite said recess.

5. Apparatus as defined in claim 2 wherein the screws extend freely through the frame and plates, the openings in said plates through which the screws extend being elongated to permit radial movement of the plates when the same are not clamped by said screws and nuts, whereby said spring fingers may be moved into and out of axial alignment with the pilot flange on the support.

6. Apparatus as defined in claim 5 wherein each plate is secured by a plurality of screws which engage a single nut in the form of a plate having a plurality of threaded openings therein.

7. Apparatus as defined in claim 5 wherein the end portions of said spring fingers are constructed to engage the pilot flange during the tightening of the screws and nuts before the plates on which said fingers are carried are drawn into face-to-face engagement with the frame.

8. A stator plate for a flywheel magneto, having a recess with a cylindrical wall adapted to receive and closely fit the periphery of a pilot flange on an engine crankcase and an end wall adapted to engage an outer end face of said pilot flange, a plurality of spring-finger carrying members mounted on the inner face of the plate with the fingers adapted to engage the inner end face of said pilot flange to hold the plate against axial displacement and to frictionally hold the plate in various positions of angular adjustment, said members being mounted on the stator plate for movement radially of said recess from positions in which their spring fingers project inwardly beyond the cylindrical wall of said recess to positions in which the spring fingers lie wholly outside such wall, each said member having a part extending therefrom and accessible for moving the member radially from one of said positions to the other, and screws and nuts for holding the members in the first-named radial positions, each screw passing freely through the stator plate with its head engaging the outer face thereof and threading into its nut, each nut being operatively engaged with its member to draw the same toward said plate, the head of each screw being accessible from the outer face of the stator plate.

9. A stator plate for a flywheel magneto, having a recess with a cylindrical wall adapted to receive and closely fit the periphery of a pilot flange on an engine crankcase and an end wall adapted to engage an outer end face of said pilot flange, a plurality of spring-finger carrying members mounted on the inner face of the plate with the fingers adapted to engage the inner end face of said pilot flange to hold the plate against axial displacement and to frictionally hold the plate in various positions of angular adjustment, said members being mounted on the stator plate for movement radially of said recess from positions in which their fingers project inwardly beyond the cylindrical wall of said recess to positions in which the fingers lie wholly outside such wall, each said member having a part extending therefrom and accessible for moving the member radially from one of said positions to the other, and screws and nuts for drawing the members toward said plate to carry the fingers against the inner end face of the pilot flange, each screw passing freely through the stator plate with its head engaging the outer face thereof and threading into its nut, the nuts being operatively engaged with the members to draw the same toward the plate and carry the fingers against said inner end face of the pilot flange when the screws are tightened and thereby adjust the pressure of the fingers on said inner end face.

10. A stator plate for a flywheel magneto, having a recess with a cylindrical wall adapted to receive and closely fit the periphery of a pilot flange on an engine crankcase and an end wall adapted to engage an outer end face of said pilot flange, a plurality of spring-finger carrying members mounted on the inner face of the plate with the fingers adapted to engage the inner end face of said pilot flange to hold the plate against axial displacement and to frictionally hold the plate in various positions of angular adjustment, said members being mounted on the stator plate for movement radially of said recess from a position in which their fingers project inwardly beyond the cylindrical wall of said recess to a position in which the fingers lie wholly outside such wall, and screws and nuts for drawing the members toward said plate and the fingers against the inner end face of the pilot flange, each screw passing freely through the stator plate with its head engaging the outer face thereof and threading into its nut, said nuts being operatively engaged with their members to draw the latter toward the plate and the fingers against said inner end face of the pilot flange when the screws are tightened and thereby adjust the pressure of the fingers on said inner end face.

11. Apparatus as defined in claim 10 wherein

the screws pass through elongated slots in said spring-finger carrying members whereby said members are guided in their radial movements.

12. A stator plate for a flywheel magneto, having a recess with a cylindrical wall adapted to receive and closely fit the periphery of a pilot flange on an engine crankcase and an end wall adapted to engage an outer end face of said pilot flange, a plurality of spring-finger carrying members mounted on the inner face of the plate with the fingers adapted to engage the inner end face of said pilot flange to hold the plate against axial displacement and to frictionally hold the plate in various positions of angular adjustment, said members being mounted on the stator plate for movement radially of said recess from positions in which their fingers project inwardly beyond the cylindrical wall of said recess to positions in which the fingers lie wholly outside such wall, each member having a bent part engageable with the pilot flange as a fulcrum, and screws and nuts for swinging said members about their fulcrums to press the fingers against the inner end face of the pilot flange, each screw passing freely through the stator plate with its head engaging the outer face thereof and threading into its nut, each nut being operatively engaged with its member to move its finger-carrying end toward and against said inner end face of the pilot flange when its screw is tightened, whereby to adjust the pressure of the fingers on said inner end face.

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Jan. 22, 1952 A. L. BROWNLEE 2,583,466

FLYWHEEL MAGNETO

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Fig. 1.

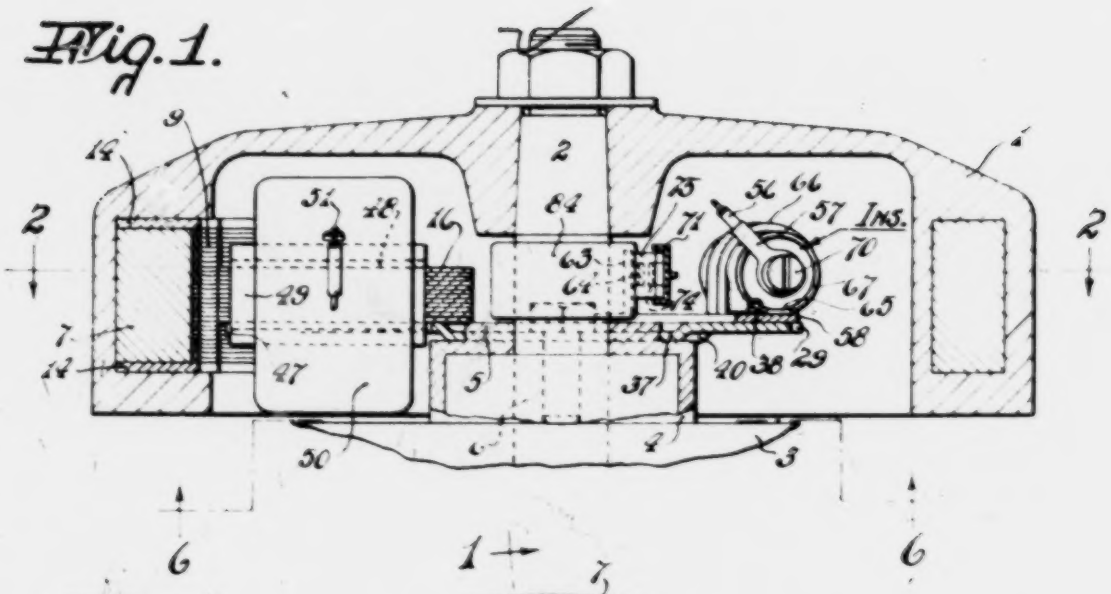
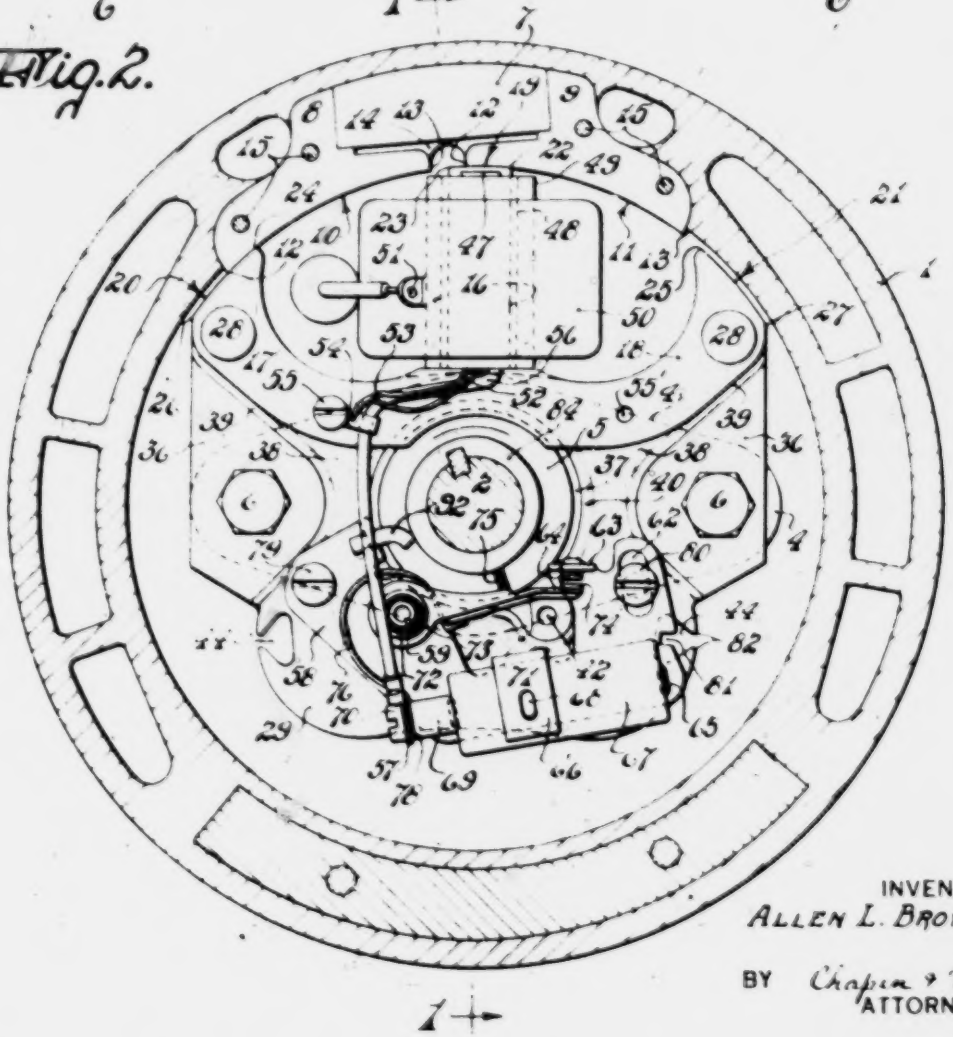


Fig. 2.



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FLYWHEEL MAGNETO

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Fig. 3.

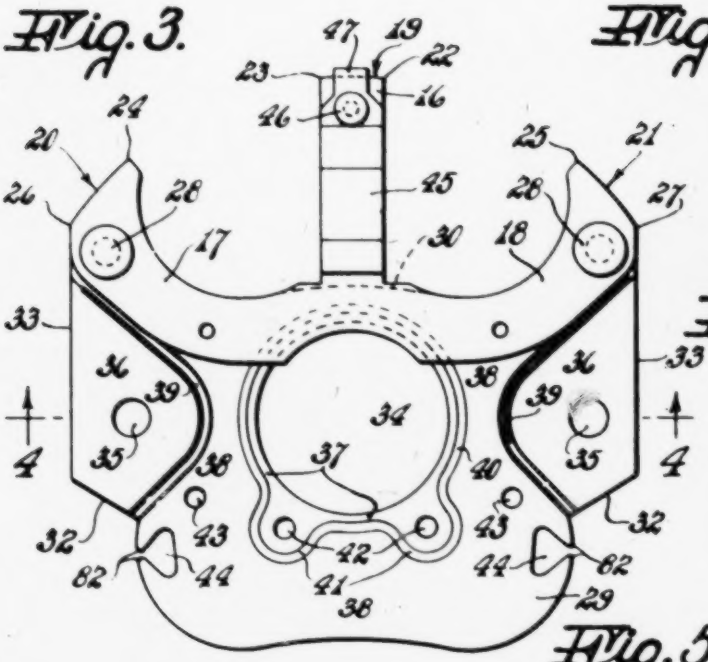


Fig. 8.

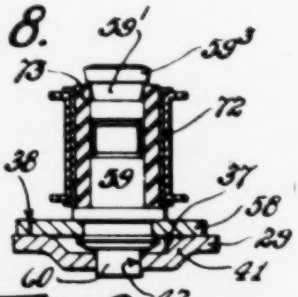


Fig. 9.

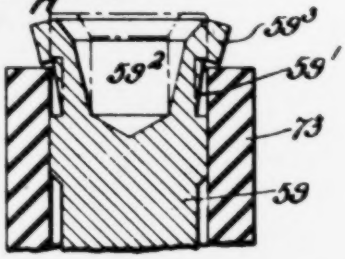


Fig. 5.

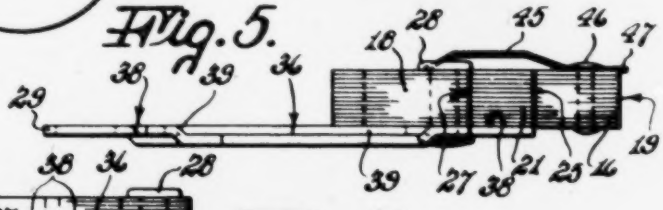


Fig. 4.

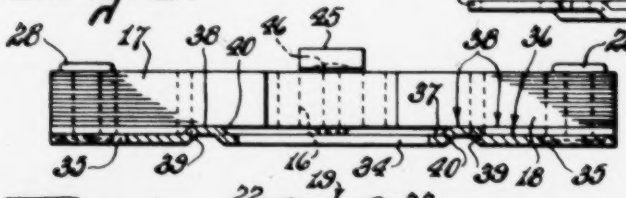


Fig. 7.

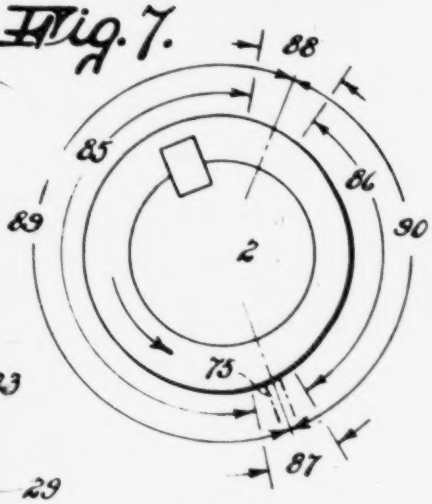
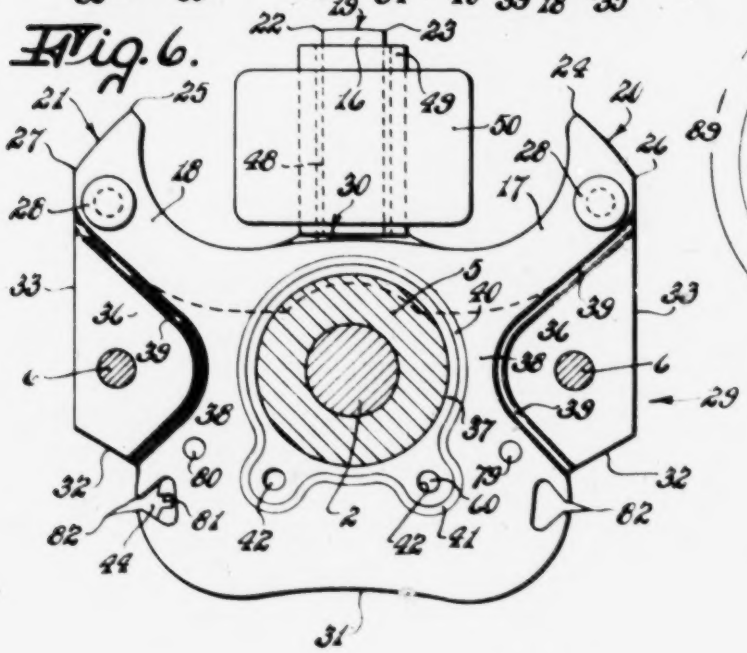


Fig. 6.



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FLYWHEEL MAGNETO

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Fig. 10.

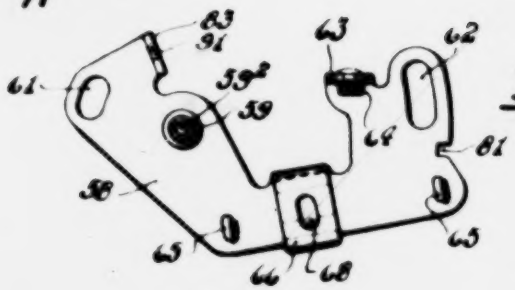


Fig. 12.

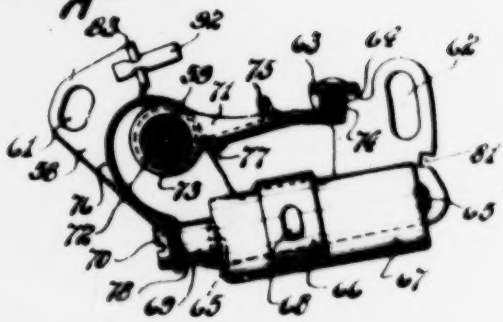


Fig. 11.

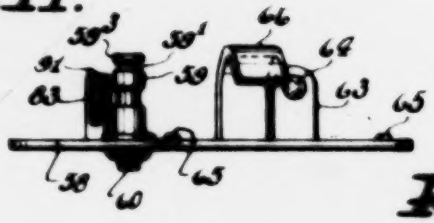


Fig. 13.

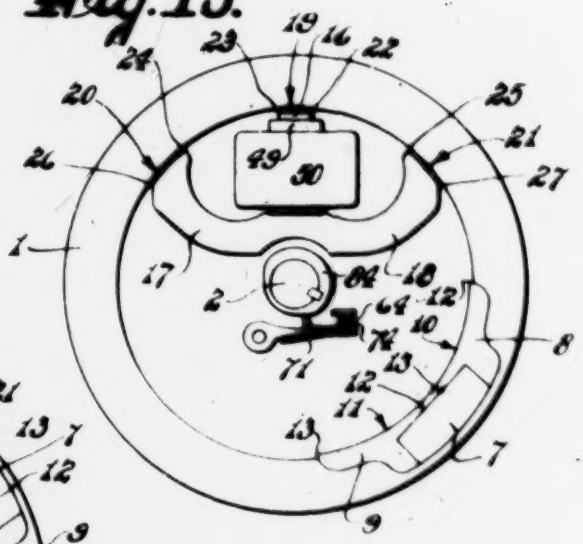
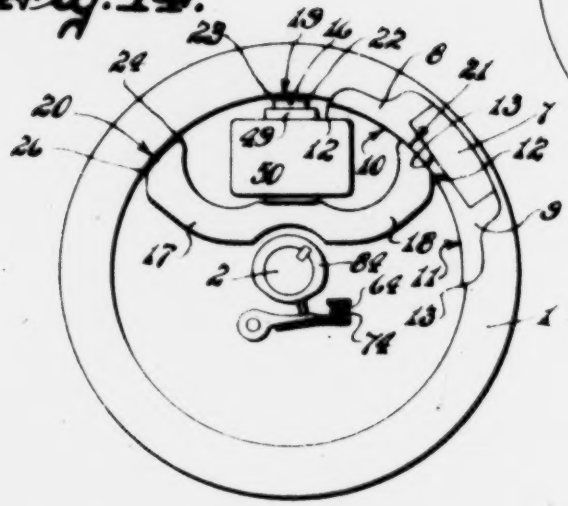


Fig. 14.



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2,583,466

UNITED STATES PATENT OFFICE

2,583,466

FLYWHEEL MAGNETO

Allen L. Brownlee, West Springfield, Mass., assignor to Wico Electric Company, West Springfield, Mass., a corporation of Massachusetts

Application June 16, 1950, Serial No. 167,399

15 Claims. (Cl. 171—209)

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This invention relates to improvements in flywheel magnetos, adapted for the ignition of internal combustion engines and, more particularly, engines, such as outboard motors, and those used on lawn mowers, motorized bicycles, scooters, chain saws and the like, which operate at very high speeds.

The invention is an improvement on that disclosed in the Harmon patent No. 2,101,392, dated December 7, 1937. The magneto disclosed in this patent is satisfactory for engines, which operate at about 300 revolutions per minute or less. It is not satisfactory for engines operating at much higher speeds because it produces each revolution, in addition to the ignition spark, an unwanted or so-called "maverick" spark, which is of sufficient intensity and occurs at such time as to adversely affect the operation of the engine by causing pre-ignition and loss of power. In this type of magneto, one complete reversal of magnetic flux through the coil-carrying core is effected once during each revolution and this flux reversal is utilized to produce the ignition spark. The breaker points which control the circuit of the primary coil, are closed at the start of such reversal and opened at the end of such reversal to produce the E. M. F., relied on for the ignition spark. This flux reversal, however, is preceded by an increase or building up of flux in the coil-carrying core and is followed by a decrease of flux through the core, both increase and decrease occurring while the breaker points are open. An E. M. F. is produced by the flux increase and also by the flux decrease. The amount of E. M. F. produced increases with the speed, other factors being equal. The E. M. F. produced following the flux reversal occurs at such a time in the engine cycle as to cause no trouble. The E. M. F. produced by the flux increase, however, occurs at such a time, as to cause pre-ignition, if the voltage is sufficiently high. The maverick E. M. F. produced at low engine speeds, say 3000 R. P. M. or less, was not high enough to cause trouble but, if the magneto is operated at high speeds, presently being used such as 5000 to 7000 R. P. M. the maverick E. M. F. becomes very high, say 3000 volts, and will cause pre-ignition and resulting power loss. As engine speeds increased from those originally used with the magneto of the Harmon patent, unsymmetrical pole shoes and/or unsymmetrical faces on the outer ends of the legs of the laminated armature were used in order to weaken the maverick E. M. F. and prevent a maverick spark of sufficient intensity to cause pre-ignition.

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This is as shown, for example, in the Alstrom and Brownlee Patent No. 2,447,727, granted August 24, 1948. As engine speeds became still higher, the use of such unsymmetrical shoes and faces was no longer effective to keep the voltage, occurring from the building up of flux, within sufficiently low limits to prevent pre-ignition and the resultant interference with engine operation.

This invention has for an object the provision of improvements in flywheel magnetos of the general type shown in the Harmon patent for preventing the occurrence of a maverick spark even though the magneto is operated at the very high speeds at present contemplated.

The invention also has for an object the provision of an improved stator plate construction for a flywheel magneto, adapted for mass production at low unit cost, being made as a stamping from thin sheet metal with offset portions shaped to give adequate rigidity at the necessary locations.

The invention has for another object the provision of a stator plate of magnetic material functioning as part of the armature which it supports.

The invention has for another object an improved stator plate with provisions for a right and left hand mounting thereon of the breaker point mechanism to adapt the latter for use with an actuating cam rotating in either direction.

The invention has for a further object the provision in a flywheel magneto of breaker point mechanism and a condenser mounted as a separate unit on a supporting plate, adapted for attachment to the stator plate of the magneto.

Another object of the invention is to anchor the spring of the breaker lever to the insulated terminal of the condenser and utilize it as an electrical conductor, both lever and condenser and the stationary point being mounted on a single plate which is adjustably secured to the stator plate, the adjustment of the breaker plate on the stator plate being for the purpose of varying the extent of opening of the breaker points and such adjustment being capable of being made without changing the force of the spring, which tends to hold the breaker points engaged.

These and other objects will best be understood from the following description of the invention in connection with the one illustrative example of it shown in the accompanying drawings, in which

Fig. 1 is a full size sectional elevational view, taken on the line 1—1 of Fig. 2, of a flywheel magneto embodying the invention;

Fig. 2 is a full size sectional plan view taken on the line 2—2 of Fig. 1, showing the parts in the positions which they occupy at the time of production of the ignition spark;

Fig. 3 is a top plan view of the stator plate and armature;

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is an end elevational view of the stator plate and armature;

Fig. 6 is a fragmentary sectional view taken on the line 6—6 of Fig. 1;

Fig. 7 is an enlarged view of the cam for actuating the breaker lever;

Fig. 8 is an enlarged fragmentary sectional view of the pivotal mounting of the breaker lever;

Fig. 9 is a much enlarged view of the upper portion of Fig. 8, illustrating how the hub of the breaker lever is held to its pivot;

Figs. 10 and 11 are plan and side elevational views of the breaker plate;

Fig. 12 is a plan view of the complete breaker unit;

Fig. 13 is a digrammatical view showing the relative positions of pole shoes and cooperating armature faces for the early limit time of closure of breaker points; and

Fig. 14 is a view similar to Fig. 13 but showing the relative positions of pole shoes and cooperating armature faces for the late limit time of closure of the breaker points.

Referring to these drawings, the magneto includes a flywheel 1 (Figs. 1 and 2) adapted to be fixed as indicated to the outer end of the crankshaft 2 of an internal combustion engine, a portion of the crankcase of which is designated 3. Such portion has a boss 4, having a cylindrical pilot hub 5 (see also Figs. 3 and 6) coaxial with the crankshaft and having tapped holes (Fig. 2), one on each side of the hub, to receive screws, such as 6, by means of which the stator element of the magneto is fixed to the crankcase.

The flywheel has a rim of non-magnetic material (Fig. 2) in which a permanent magnet 7 and two pole shoes 8 and 9 are embedded or otherwise fixed thereto. These shoes 8 and 9, which are fixed one to each polar end of magnet 7, have concave curved faces 10 and 11, respectively, which are of equal radius and coaxial with the flywheel. The adjacent edges of these shoes are separated by a small acute angle, as shown about 9°, and they are of equal angular extent and symmetrically located with reference to a radial center line passing through the magnet at a location centrally between its polar ends. The leading and trailing edges 12 and 13, respectively, of each shoe are separated by an acute angle several times larger, about four as shown, than the angle which separates their adjacent edges. The angular spacing between the trailing edge 13 of the pole shoe face 11 and the leading edge of the pole shoe face 10 is a little less than 90°, say 85°. The shoes are made up of laminations (Fig. 1) clamped between two non-magnetic plates 14 by rivets indicated in Fig. 2 at 15. This fastening means holds the two shoes and the magnet together to facilitate the embedding of these parts in the rim of the flywheel during the casting of the same.

The stator of the magneto includes a three-legged armature structure made up of iron laminations and stationarily supported inside the flywheel as indicated in Fig. 2. This armature is shown separately in Figs. 3, 4 and 5. It includes a central leg 16, which is disposed radially of the flywheel and forms a core, and two outer legs 17 and 18, which are located one on each side of leg 16 and the inner ends of which are united to the inner end of the central leg. The legs 17 and 18 extend outwardly in diverging relation with the central leg. The legs 16, 17 and 18 have on their outer ends curved faces 19, 20 and 21, respectively, which have the same radius and one just slightly less than the radius of the faces 10 and 11 of the pole shoes and are intended to be positioned coaxially of the flywheel as will later appear. The central leg or core 16 (Fig. 4) is of approximately square cross section. The angular spacing (Fig. 2) between the front and rear edges 22 and 23, respectively, of face 19 is just slightly greater than the spacing between the adjacent edges 13 and 12 of the faces 10 and 11 of pole shoes 8 and 9, respectively. The angular spacing between the front edge 24 of the face 20 and the rear edge 23 of face 19 is just slightly less than the angular spacing between the leading and trailing ends 12 and 13 of either pole shoe. The angular spacing between the front edge 22 of face 19 and the rear edge 25 of face 21 is equal to that between the leading and trailing ends 12 and 13 of pole shoe 9 and preferably and as shown to that between the edges 24 and 23. The angular spacing between the rear edge 25 of face 20 and its front edge 24 equals the angular spacing between the rear edge 25 of face 21 and its front edge 27 and exceeds the angular spacing between the front and rear edges 22 and 23 of face 19. The armature structure, as shown, is symmetrical with reference to the radial center line of core 16.

The armature described is secured by rivets 28 to a supporting plate 29, as best shown in Figs. 3, 4, 5 and 6. This plate is made as a stamping of thin sheet steel. One end edge 30 (Figs. 3 and 6), of this plate substantially coincides with the outer face of the legs 17 and 18 and the curved faces 20 and 21 on their outer ends. The magnetic quality of this plate is utilized as part of the armature in that it adds to the cross section of the legs the equivalent of two laminations (Fig. 5). The other end edge 31 of plate 29 is complementary to the first-named edge 30, except for the angular edges 32. The side edges 33 are straight and parallel. The contour of the plate is not critical. However, it is important that all edges of the plate, except those which coincide with the faces 20 and 21 on the outer ends of legs 17 and 18, be spaced from the axis of the flywheel by radial distances substantially less than the radius of the faces 10 and 11 of the pole shoes in order to maintain a large air gap between the magnet shoes 8 and 9 and the magnetic plate 29. This plate has a circular opening 34 to closely fit the outer periphery of the pilot hub 5 and is mounted thereon. On each side of opening 34 are holes 35 for the screws 6, which clamp plate 29 against the face of boss 4. This plate is made of thin steel and as shown has a thickness of about $\frac{1}{16}$ inch. Certain portions of the plate are offset from other portions thereof by a distance about equal to the thickness of the plate. Thus, the side areas 36 and a central area 37 are in a plane lower than the parallel plane in which the intervening area 38 is located. This offsetting provides the necessary rigidity for the thin plate. It results in half ribs, such as 39, which connect the portions 36 and 38 and a half rib 40, which connects the portions 37 and 38 and

is substantially annular except for two offsets 41, extending one around each of two holes 42, which are pilot holes for locating with precision the pivot of the breaker mechanism, as will later appear. The plate also has two tapped holes 43 for use in attaching the breaker mechanism and two notches 44 for a purpose to be later described. The stator plate 29 and all the parts described, (except holes 35) are symmetrical about an extended diameter of opening 34, which diameter passes centrally through the core 16. The holes 35 are unsymmetrically spaced from the opening 34 to prevent mounting the plate on the crankcase in any other than the illustrated position.

The plate described is fixed, as shown in Fig. 2, by two screws 8 which pass through holes 35 and thread into the tapped holes in boss 4, the opening 34 closely fitting the outer periphery of pilot hub 5 and accurately locating the curved faces 18, 20 and 21 of the armature in coaxial relation with the crankshaft 1 and flywheel 2 and the pole shoes 8 and 9 of the magnet. The bottom face of the portion 37 of plate 29 abuts the shoulder at the bottom of the pilot hub 5 (Fig. 1). This leaves sufficient clearance between the end face of hub 5 and the lower face of the laminated armature, which partially overlaps the opening 34. The half-rib 40, which encompasses the part 37, gives strength and rigidity to the plate at a location, which is very important because of its function of locating the curved faces of 18, 20 and 21 coaxially of the flywheel and crankshaft. It is also important to have rigidity between the core structure and the areas of plate 29, which are clamped to the engine crankcase by screws 6, and the half ribs 39 (Fig. 2), provide this rigidity. Each such half rib partialy encompasses a fastening screw 6 and then follows along an outer portion of the lower face of the outer legs of the armature structure.

Referring again to the armature, the central leg or core 16 (Figs. 3, 4 and 5) has fixed to one face thereof a spring 46. As shown, this spring is secured near one end by a rivet 48 and has an extension 47 beyond the rivet. A coil unit (Figs. 2 and 6), comprising a central tubular core 48 of hollow square cross section; a primary coil 49 mounted upon the core; and a secondary coil 50 mounted upon the primary coil 49, is placed on core 16. As the core 48 is slide on core 16, the spring 46 will be compressed to some extent and its acts to take up any play between core 16 and the tubular core 48, which encompasses it. The coil unit is held in place by bending the extension 47 (Figs. 1 and 2) over and upon the upper end face of the core 48. Secondary coil 49 has a terminal 51 for connection to the spark plug of the engine. The coils 49 and 50 (Fig. 2) have ground wires 52 and 53, respectively, which are connected together and soldered to a clip 54. This clip is fastened to the armature structure by a self tapping screw 55 threaded into one of two holes 56', provided in such structure. The other terminal of the primary coil 49 is connected to a wire 56, having a lug 57 on its outer end. The clip 54 is bent over and upon this wire 56 to hold it in place.

The breaker point mechanism and the condenser therefor are provided as a separate unit, which may be readily removed form and replaced on the stator plate 29. One such unit is shown separately in Fig. 12. Another similar unit (not shown) is made reversely to the Fig. 12 unit and can be mounted on plate 29 for use when the flywheel and the cam for actuating the breaker

point mechanism rotates clockwise istead of counterclockwise, as shown. The breaker point mechanism includes a flat plate 58 (Figs. 10 and 11), having riveted thereto a stud 59, which projects from the top face thereof and a coaxial pilot 60, which projects from the bottom face thereof. The plate 58 (Fig. 10) also has two slots 61 and 62 thereof, each curved coaxially with the stud 59 and pilot 60. From one edge of plate 58, near slot 62, a lug 63 is bent up at right angles and, secured to this lug, is the stationary breaker point 64. The plate 58 has two spaced parallel abutments 65 struck up therefrom. Between these abutments is a curved clasp 66 bent up from one edge of plate 58. This clasp has a curved portion, of somewhat more than 90° extent, bent to the radius of the casing of a condenser 67. This casing is placed on the left hand abutment 65 with one end beneath clasp 66 and is then pressed to the right until its leading end engages the right hand abutment 65. The left hand end of the casing will then lie just to the right of the left hand abutment and the condenser will be pressed tightly to the plate with its ends engaging the abutments to prevent lengthwise displacement. A hole 68 is provided in clasp 66 to permit the metallic casing 67 to be soldered to clasp 66 if desired. The casing 67 is the ground terminal of the condenser contained in it. The other terminal of the condenser is a small post 69 having a screw 70 threaded therein.

The breaker lever 71 (Fig. 12) is of metal and has at one end a hub 72 encompassing a tube 73 of insulating material, which closely fits the stud 59. The ends of tube 73 (Fig. 8) project beyond the ends of this hub and thus the hub and lever are insulated from the stud 59 and plate 58. The upper end of stud 59 is expanded to hold the breaker arm against removal from the stud. It is important to spread the upper end of the stud to overlie the upper end face of tube 73 without causing any portion of the stud that lies within the tube from being expanded against the inner peripheral surface of the tube. To secure this result, a circumferential groove 59' is formed in the outer periphery of the stud near its upper end. Most of this groove will lie within the tube but the upper wall of the groove is located slightly above the end face of tube 73. Then a punch is forced in the hole 59² in the upper end of stud 59, which expands the upper part of the stud throwing the end 59³ outwardly and a little downwardly until it overlies the upper end face of tube 73 and is spaced therefrom by the desired clearance. The peripheral wall of groove 59' is necessarily expanded to some extent but since it was originally of less diameter than the tube, it can and does expand as much as necessary without touching the internal periphery of the tube and causing binding. The outer end of lever 71 has fixed thereto a breaker point 74 to cooperate with point 64. Fixed to the lever 71 at a location intermediate its ends is a cam follower 75 of insulating material. A spring 76 has right angular bent ends 77 and 78. A portion of the spring passes through a slot in the breaker lever and one end 77 abuts the outer face of the lever. This spring curvees around hub 72 and then extends to the post 69 where its end 78 is secured together with the lug 57 on wire 56 (see Fig. 2) by screw 70. The spring serves as an electrical conductor between the insulated breaker lever and the insulated terminal of the condenser. The spring exerts a radially outward

thrust (to the right as viewed in the drawings) on the breaker lever and thus takes up any clearance between stud 69 and tube 73 and prevents sliding of breaker point 74 on breaker point 64.

The breaker mechanism unit is mounted on the stator plate 29 by laying the breaker plate 58 on plate 29 and inserting the pilot 60 in the left hand pilot hole 42. Screws 78 and 80 are inserted through slots 61 and 62, respectively, to clamp the plates together. Adjustment of the breaker plate around the pivotal axis of the breaker lever may be made to vary the extent of opening of the breaker points and since spring 76 is anchored to condenser 67 on plate 58, the force of the spring, acting to hold the points engaged is not changed by the adjustment. This adjustment may be made while screws 78 and 80 are loosened, by inserting a screw driver in a notch 44 in plate 29 and into a notch 81 in the breaker plate and swinging the screw driver as a lever, using either the upper or lower of the knife edges 82 as a fulcrum, accordingly as the plate 58 is to be turned clockwise or counterclockwise, respectively. The screws 78 and 80 are then tightened to clamp plate 58 in adjusted position. If the flywheel turns clockwise, a reversed form of breaker mechanism is used and its pilot is inserted in the right hand pilot hole 42. Otherwise the plate of the reversed form of breaker mechanism is mounted, adjusted and secured in a manner similar to that described. The second notch 44 is provided to serve as a fulcrum for a screw driver, when used to adjust the plate of the reversed form of breaker mechanism. It is to be noted that the same shaped piece of metal is used for the plate of the reversed form of breaker mechanism but the lug 64, clasp 66 and seat 65 and a lug 83 are bent in the opposite direction from the top face of plate 58.

The follower 75 rides on the periphery of a cam 84 fixed on crankshaft 2. The counterclockwise rotation of this cam creates a thrust on follower 75 to the right but the spring 76 has taken up any clearance between the stud 69 and tube 73 so that the cam will not cause relative sliding of the breaker points. Reverse rotation of the cam would create a thrust to the left on the breaker lever and tend to slide the breaker point 74 on point 64 against the force of spring 76. That is why it is better to provide the reversely formed breaker mechanism and use it where the rotation of the cam is clockwise.

The cam 84 is constructed as best shown in Fig. 7. It has a high dwell surface 85, a low dwell surface 86, a rise surface 87 and a drop surface 88. When the follower 75 is engaged by the rise surface 87, the breaker points will be opened. This occurs at the position shown in Fig. 2. The high dwell surface 85 holds the points open for a substantial interval and then the drop surface 88 allows the points to close and the low dwell surface 86 maintains them closed for an interval of about 137° as shown. When the breaker points are closed, the cam follower 75 does not engage the surface 86, allowing the breaker spring 76 to press the points tightly together. The breaker points open when the cam is positioned as shown in Fig. 2 and then remain open while the cam travels through the angle 89, then closing and remaining closed while the cam is travelling through the angle 90. Fig. 13 shows diagrammatically the position of shoes relatively to the armature structure, when the breaker points close, and Fig. 2 shows the position when they open. The Fig. 13 position provides for a large factor of safety because the primary coil circuit does not need to be closed until a position such as shown in Fig. 14 is reached, where the leading edge 12 of the leading pole shoe 8 is no closer than 5° to the front edge 22 of the curved surface 19 of core 16. As actually shown, the angle 90 between closed and open position is 137°. This angle 90 could be reduced to about 74°, which represents the latest limit for the closing of the primary coil circuit and is shown in Fig. 14. The reason for using an earlier closing of the breaker points is to insure that they will be actually engaged when the pole shoes reach the Fig. 14 position. When the cam allows the breaker points to be engaged by the spring, they will engage but they may not immediately remain in engagement, particularly when the engine is being operated at the very high speeds, such as are prevalent today. The movable breaker point may impinge on the fixed breaker point and rebound, separating the points, after which, the points may reengage and again rebound and separate and then close and remain closed. The mass of breaker level is made as small as possible in order to reduce as much as possible the rebounding of the movable breaker point following its initial engagement with the fixed breaker point. However, for full insurance that the points will be closed from at least the Fig. 14 position to the Fig. 2 position of the pole shoes, it is better to close the breaker points at some earlier time, as for example when the pole shoes are in the Fig. 13 position.

The lug 63 on breaker plate 58 is provided with a vertical slot 91 (Figs. 10 and 11) for the purpose of retaining one end of a piece 92 (Fig. 12) of flexible, absorbent material, such as felt, the other end of which engages the periphery of cam 84 (Fig. 2), and acts as a wiper.

The operation will next be described. Assuming that the flywheel 1 and cam 84 are rotating in a counterclockwise direction, the cam allows the breaker points 64 and 74 to engage when the pole shoes 8 and 9 of the magnet 7 reach the position shown in Fig. 13. As above set forth, this early engagement of the points is to provide for a margin of safety to insure that the movable breaker point 74 finally comes to rest in engagement with the stationary breaker point 64 by the time that the pole shoes reach the Fig. 14 position because it is desired to have the circuit of the primary coil 49 closed when the leading edge 12 of the leading pole shoe 8 approaches closely to the front edge 22 of the face 19 on the core 16 in order to prevent the sudden change of flux, which would otherwise occur at this time if the circuit to the primary coil was open, and the production of a spark of sufficient intensity to ignite the mixture in the cylinder of the engine during the building up of flux in one direction in core 16. The primary circuit should be closed not later than when the rotor reaches the Fig. 14 position and a gap of five degrees exists between the leading edge 12 of shoe 8 and the front edge 22 of the face 19 on core 16 or somewhat greater than the air gap subsequently created between the trailing edges 13 of the shoes 8 and 9 and the rear edges 23 and 25, respectively, of the faces 19 and 21 of the armature at the time of production of the ignition spark (the condition shown in Fig. 2). As shoes 8 and 9, continuing their counterclockwise movement, traverse the curved faces 19 and 21 of core 16 and leg 17, respectively, flux is built up in one direction

through core 16, say for example, from shoe 8 through core 16 and legs 17 to shoe 9. This building up of flux is retarded because the circuit of the primary coil is closed and no substantial E. M. F. is produced. As the shoes 8 and 9 continue their counterclockwise movement the leading edge 12 of shoe 8 will engage the face 20 of leg 17 and the leading edge of shoe 9 will engage the curved face 19 of core 16. This occurs shortly before the trailing edges 13 of the shoes 8 and 9 respectively leave the edges 23 and 25 of the faces 19 and 21, respectively. As the shoes leave the last-named edges, the former magnetic circuit through core 16 is broken and one established in the opposite direction. That is, flux now passes from shoe 8, through leg 17 and then through core 16 to shoe 9. The closed primary coil retards this flux change but when the trailing edges of the shoes 8 and 9 are spaced from edges 23 and 25 of faces 19 and 21, respectively, by a sufficient air gap, for example, as shown in Fig. 2, the cam 84 separates the breaker points 74 and 84 and a reversal of flux occurs through core 16 and the high voltage for the ignition spark is produced. The flux reversal consists of a decrease from a maximum in one direction to zero followed by an increase from zero to a maximum in the opposite direction. On continued rotation, the shoes 8 and 9 will leave the faces 20 and 19 respectively, causing a decrease in flux through core 16 to zero. An E. M. F. will be produced by this decrease in flux but it occurs at such a time in the engine cycle as to do no harm.

The closing of the breaker points during the building up of flux in the first-named direction to suppress the maverick spark, which would cause pre-ignition, limits the maximum to which the flux can build up in such direction and causes a loss. To help offset this loss, several compensating factors have been employed. A magnet, having much higher coercive force than any available at the time the magneto of the Harmon patent was made is used. The number of turns in the primary coil has been reduced to lessen the choking effect of the call, when in closed circuit. And the design of the armature is of great importance. The particular armature shown has a short core, short pole shoes and leakage is low. With this magnetic circuit as a basis, I have been able by the use of compensating factors to secure enough build-up of magnetic flux to provide adequate ignition under all usual conditions of engine operation. The spark at the higher speeds is not as large as it is at lower speeds but it is adequate for ignition at that time. The more difficult ignition condition is when the engine is operated at lower speeds by retarding the time of ignition and that condition is met by the better spark then produced. The use of a lesser spark at the higher engine speeds at which the engine is operated most of the time is an advantage in that it affords longer life of the breaker points. Thus, the invention provides for the suppression of a maverick spark shortly prior to the ignition spark by closing the circuit of the primary coil during the building up of flux in the coil-carrying core that occurs just prior to the reversal of flux through such coil that is utilized to produce the ignition spark. While this tends to decrease the maximum to which flux can build up in one direction in the core and thus to lessen the total amount of the flux change during the reversal, nevertheless, by proper design of the electrical and magnetic components of a magneto, having the particular type of magnetic circuit herein shown, it is possible to secure sufficient flux change to provide adequate ignition for the purpose under all usual conditions of engine operation.

What is claimed is:

1. A flywheel magneto, comprising, a flywheel, a single pair of pole shoes fixed to the flywheel and angularly spaced about the axis of revolution thereof, said shoes having curved polar faces of equal radius coaxial with the flywheel, the adjacent edges of the faces of the two shoes being separated by a small acute angle, the leading and trailing edges of the face of each shoe being separated by an acute angle several times larger than the first-named angle, a source of magnetic flux magnetically interconnecting said shoes, an armature of magnetic material stationarily mounted inside the flywheel and having three legs which are magnetically connected together at their inner ends and diverge outwardly, said legs having on their outer ends curved faces of a radius slightly less than the radius of said pole shoe faces and coaxial therewith, the faces on said legs being angularly spaced about said axis to cooperate with the shoes during rotation of the flywheel, the angular spacing of the front and rear edges of the curved face on the central leg of the armature being substantially commensurate with the angular spacing between the adjacent edges of the two pole shoes, the curved faces on said legs being separated by an angle substantially commensurate with that between the leading and trailing edges of a pole shoe, primary and secondary coils on the central leg of the armature, said shoes being operable on rotation of the flywheel to bridge the polar ends of the source of flux through the central coil-carrying leg first through a first one of the outer legs and then through a second one of the outer legs, whereby a magnetic circuit is created through the coils first in one and then in the other direction, an electrical circuit including said primary coil, and means actuated with the rotation of the flywheel for closing said circuit once during each revolution of the flywheel and before the leading edge of the leading pole shoe approaches closer than five degrees to the front edge of the curved face on said central leg and maintaining such circuit closed until the leading edge of the leading pole shoe connects with the front part of the curved face on the second outer leg and its trailing edge is spaced from the rear edge of the central leg by about three degrees, and the leading edge of the trailing pole shoe connects with the front part of the curved face on the central leg and the trailing edge of the trailing shoe is spaced from the rear edge of the curved face on the first outer leg by about three degrees, and then opening said circuit.

2. A flywheel magneto, comprising, a flywheel, a single pair of pole shoes fixed to the flywheel and angularly spaced about the axis of revolution thereof, said shoes having curved polar faces which are of equal radius and equal angular extent and which are coaxial with the flywheel, the adjacent edges of said faces being separated by a small acute angle, and the leading edge of one shoe being separated from the trailing edge of the other shoe by an angle of about ninety degrees, a source of magnetic flux magnetically interconnecting said shoes, an armature of magnetic material stationarily mounted inside the flywheel and having three legs which are magnetically connected together at their inner ends

and diverge outwardly, said legs having on their outer ends curved faces of a radius slightly less than the radius of said pole shoe faces and coaxial therewith, the faces on said legs being angularly spaced about said axis to cooperate with the shoes during rotation of the flywheel, the angular spacing of the front and rear edges of the curved face on the central leg of the armature being substantially commensurate with the angular spacing between the adjacent edges of the two poles shoes, the curved faces on said legs being separated by an angle slightly less than that between the leading trailing edges of the curved face of a pole shoe, the curved faces on said outer legs being symmetrically spaced with reference to a radial line passing centrally through the central leg, primary and secondary coils on the central leg of the armature, said shoes being operable on rotation of the flywheel to bridge the polar ends of said source of flux through the central coil-carrying leg first through a first one of the outer legs and then through a second one of the outer legs, whereby a magnetic circuit is created through the coils first in one and then in the other direction, an electrical circuit including said primary coil, and means actuated with the rotation of the flywheel for closing said circuit once during each revolution of the flywheel and before the leading edge of the leading pole shoe approaches closer than five degrees to the front edge of the curved face on said central leg and maintaining such circuit closed until the leading edge of the leading pole shoe connects with the front part of the curved face on the second outer leg and its trailing edge is spaced from the rear edge of the central leg by about three degrees, and the leading edge of the trailing pole shoe connects with the front part of the curved face on the central leg and the trailing edge of the trailing shoe is spaced from the rear edge of the curved face on the first outer leg by about three degrees, and then opening said circuit.

3. A stator for a flywheel magneto, comprising a stator plate of thin sheet steel adapted to be secured to the crankcase of an engine and having a cylindrical opening therethrough adapted to receive the pilot hub on such crankcase, a laminated-iron armature fixed to said plate and having three legs which are magnetically interconnected at their inner ends and which diverge outwardly and terminate with curved outer end faces of equal radius located coaxially of said opening and in angularly spaced relation with respect to said axis, primary and secondary coils on the central leg of said armature, said plate having portions contiguous with one side face of the outer legs of the armature and substantially coextensive with such faces, whereby such steel portions function as magnetic parts of said outer legs, the outer peripheral margins of the plate except at the curved faces of the outer legs being spaced from the axis of said opening by dimensions substantially less than the radius of said curved faces.

4. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on said armature and having one terminal of each grounded thereto, and control means or the primary coil mounted as a separate unit on said stator plate and including a second plate secured to the stator plate for convenient removal and replacement, a breaker point fixed to the second plate, a breaker arm of electrical conducting material pivoted at one end to and insulated from the second plate and having near its other end a breaker point yieldingly urged toward the fixed breaker point, a condenser fixed to the second plate and having one terminal grounded thereto, and electrical connections from the other terminal of the condenser and the other terminal of the primary coil to said breaker arm.

5. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on said armature and having one terminal of each grounded thereto, a breaker arm of electrical conducting material pivotally supported at one end and insulated from said plate and having near its other end a breaker point, a relatively stationary breaker point supported by said plate for cooperation with the first breaker point, a condenser supported by said plate and having one terminal grounded thereto, a spring for moving the breaker arm to engage the breaker points, said spring having one end fixed to the breaker arm and its other end fixed and electrically connected to the other terminal of the condenser, and a wire connecting the other terminal of the primary coil to the last-named terminal of the condenser.

6. A stator for a flywheel magneto, comprising, a stator plate, an armature of magnetic material fixed thereto, primary and secondary coils mounted on the armature and each having one terminal grounded to the armature, and control means for the primary coil mounted as a separate unit on the stator plate and including a second plate mounted on the stator plate, a breaker point fixed to said second plate, a breaker arm of electrical conducting material pivotally connected at one end to and insulated from the second plate and having fixed thereto near its other end a breaker point for cooperation with the first-named breaker point, a condenser, a metallic casing enclosing the condenser and forming one terminal thereof, said casing being mounted in fixed position on the second plate and thereby grounded thereto, a post fixed to and insulated from said casing and forming the other terminal of the condenser, a spring for moving the breaker arm in one direction to engage the breaker points and yieldingly holding them engaged, said spring being fixed at one end to the breaker arm and at the other end to said post, a wire connecting the other end of the primary coil to said post, and means for securing the second plate to the stator plate for angular adjustment about the pivotal axis of the breaker arm for the purpose of adjusting the extent of opening of the breaker points; the second plate, carrying the condenser casing to which said spring is anchored, being adjustable on the stator plate without varying the force of the spring acting to hold the breaker points engaged.

7. In a stator for a flywheel magneto, a stator plate of thin sheet metal having a cylindrical opening therethrough adapted to receive the pilot hub of an engine crankcase and having holes therethrough one on each side of said opening adapted to receive screws for fastening the plate to such crankcase, said plate having certain face portions in one plane and certain other face portions in another closely-spaced parallel plane, and integral connecting parts between the face portions in different planes, said parts forming half-ribs for stiffening the plate, an armature crossing said plate above said opening and above

said holes and secured at its ends to a portion of said plate that lies in one said plane, said holes located one in each of two other portions located in the other of said planes, the half-rib connecting parts between each latter portion and the portion to which the armature is secured each extending around the inner side of the hole therein and thence diverging outwardly along the inner face of the armature.

8. In a stator for a flywheel magneto, a stator plate of thin sheet metal having a cylindrical opening therethrough adapted to receive the pilot hub of an engine crankcase and having holes therethrough one on each side of said opening adapted to receive screws for fastening the plate to such crankcase, said plate having certain face portions in one plane and certain other face portions in another closely-spaced parallel plane, and integral connecting parts between the face portions in different planes, said parts forming half-ribs for stiffening the plate, an armature crossing said plate above said opening and above said holes and secured at its ends to a portion of said plate that lies in one said plane, said holes located one in each of two other portions located in the other of said planes, the half-rib connecting parts between each latter portion and the portion to which the armature is secured each extending around the inner side of the hole therein and thence diverging outwardly along the inner face of the armature, said opening being formed in an annular portion in the second-named plane and the half-rib part which connects such annular portion to portions in the other plane being substantially annular and coaxial with said opening.

9. A breaker mechanism, comprising, a plate, a stud fixed thereto and projecting from one face thereof, curved slots in said plate one on each side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point fixed to the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed to said lug, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points.

10. A breaker mechanism, comprising, a plate, a stud fixed thereto and projecting from one face thereof, curved slots in said plate one on each side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud and having a breaker point on its other end, a lug upturned from said first-named plate at right angles, a breaker point fixed to said lug, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points, said spring fixed at one end to said arm and at the other end to the other terminal of said condenser.

11. A breaker mechanism, comprising, a plate, a stud fixed to and projecting from one face of the plate and having a coaxial pilot projecting from the other face of the plate and adapted for closely fitting engagement in a pilot hole in a support to locate said stud with precision on the support, curved slots in said plate one on each side of said stud and concentric with the latter, said slots adapted to receive screws for fastening the plate to such support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point on the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed thereto, a condenser secured to said plate with one terminal grounded thereto, and a spring for the breaker arm tending to move the latter to engage the breaker points.

12. A breaker mechanism, comprising, a plate, a stud fixed to and projecting from one face of the plate, curved slots in said plate one on eacn side of said stud and concentric therewith, said slots adapted to receive screws for fastening the plate to a support, a breaker arm of electrical conducting material pivotally mounted at one end on and insulated from said stud, a breaker point fixed to the other end of said arm, a lug upturned from said plate at right angles, a breaker point fixed to said lug, a condenser on said plate, the latter having bent upwardly from one edge a clasp with a curved part to partially encircle the condenser, and abutments one for each end of the condenser struck up from said face of the plate one on each side of said clasp; said clasp pressing the condenser against the plate and frictionally holding it on the plate and between the abutments, and a spring for the breaker arm tending to move the latter and engage the breaker points.

13. A reversible mounting for the breaker mechanism of a magneto, comprising, a supporting plate for the armature of the magneto having a pilot hole for locating the armature relatively to the driving shaft of the magneto, said plate having right and left pilot holes of equal diameter located equidistant from the center of the first-named pilot hole and spaced one from another by a predetermined angle, said plate having a second pair of holes of equal size located equidistant from the center of the first-named pilot hole and in angularly spaced relation, the holes of the second pair being located on opposite sides of a radial line extending from the center of the first-named pilot hole and bisecting said angle between the second-named pilot holes and having an equal angular spacing with reference to said line, a second plate for supporting the breaker mechanism, a pivot stud fixed to and projecting from one face of the second plate, a pilot stud fixed to and projecting from the opposite face of the second plate coaxially of the pivot stud and having a diameter such as to closely fit in either of said pilot holes, said second plate having therethrough two slots both curved coaxially of the pivot and pilot studs, the radial center line of one slot being equal to the center to center distance between either of the second-named pilot holes and the nearest of the second pair of holes and the radial center line of the other slot being equal to the center to center distance between the same pilot hole and the more remote of the second pair of holes, the second plate being mounted on the first plate with its pilot stud engaged in a selected one of the second named pilot holes, fasteners extending one through each of the curved slots and one into each of the second pair of holes for holding the plates together in various positions of angular adjustment, a breaker lever pivotally mounted on said pivot stud, cooperating breaker points one on said lever and one on the second plate, and a spring for yieldingly holding the breaker points engaged.

14. The combination of claim 13, in which the first plate has two notches one in each of two opposite edges, two walls of each notch intersecting the adjacent one of said edges to form two opposed and closely-spaced knife edges, the two notches and the pairs of knife edges being symmetrically disposed with reference to said radial line, said second plate having in one edge a notch adapted to lie over one or the other of the first-named notches according to whether the pilot stud is engaged in the right or the left pilot hole, whereby a screw driver can be engaged in the notch of the second plate and fulcrummed on one or the other of the adjacent knife edges to move the second plate about the axis of the pivot and pilot studs.

15. A pivotal mounting, comprising, a stud having near one end a flange, and a member having a hub mounted to turn on said stud and having one end face engaging said flange, said stud having its other end spread to overlie the other end face of said hub and retain the latter in axial position on the stud, such end being connected to

the underlying bearing portion of the stud by a stem of less diameter than the bearing portion and located for the most part within said hub, whereby spreading of the stem can occur when the outer end is spread without causing engagement of the stem with the interior periphery of the hub.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,583,466 January 22, 1952

ALLEN L. BROWNLEE

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 1, line 12, for "300" read *3000*; column 5, line 28, for "encompases" read *encompasses*; line 51, for "compresed" read *compressed*; column 8, line 25, for "level" read *lever*;

and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 15th day of April, A. D. 1952.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.

March 25, 1952 J. C. SLONNEGER 2,590,134

INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 1

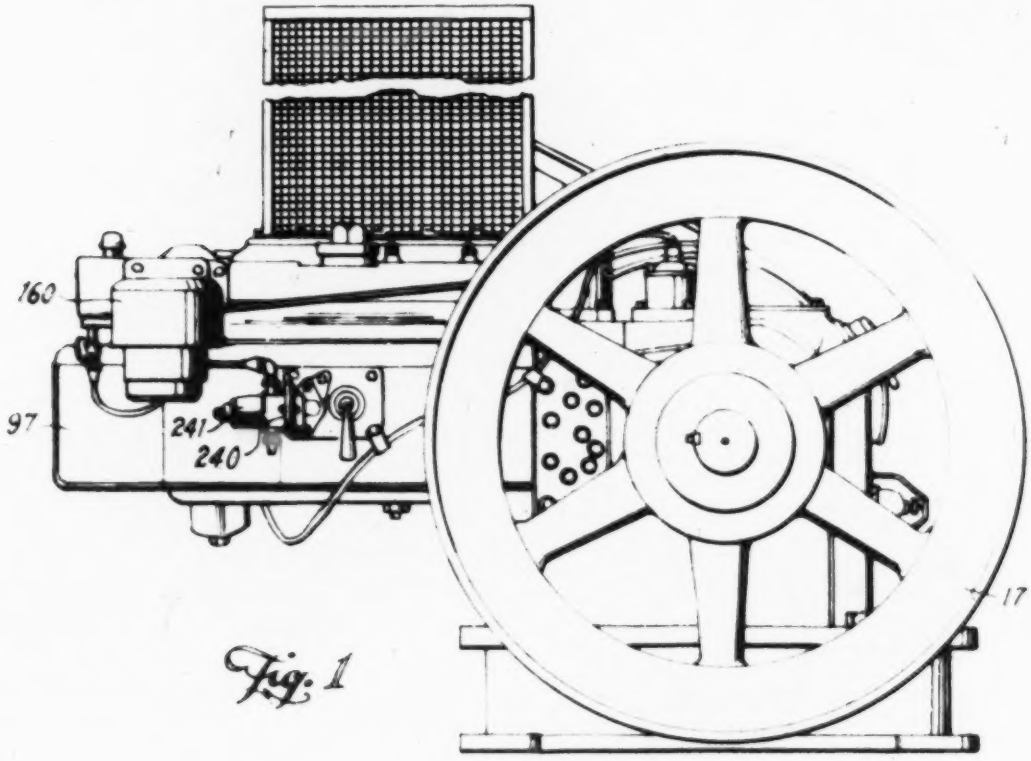

Fig. 1

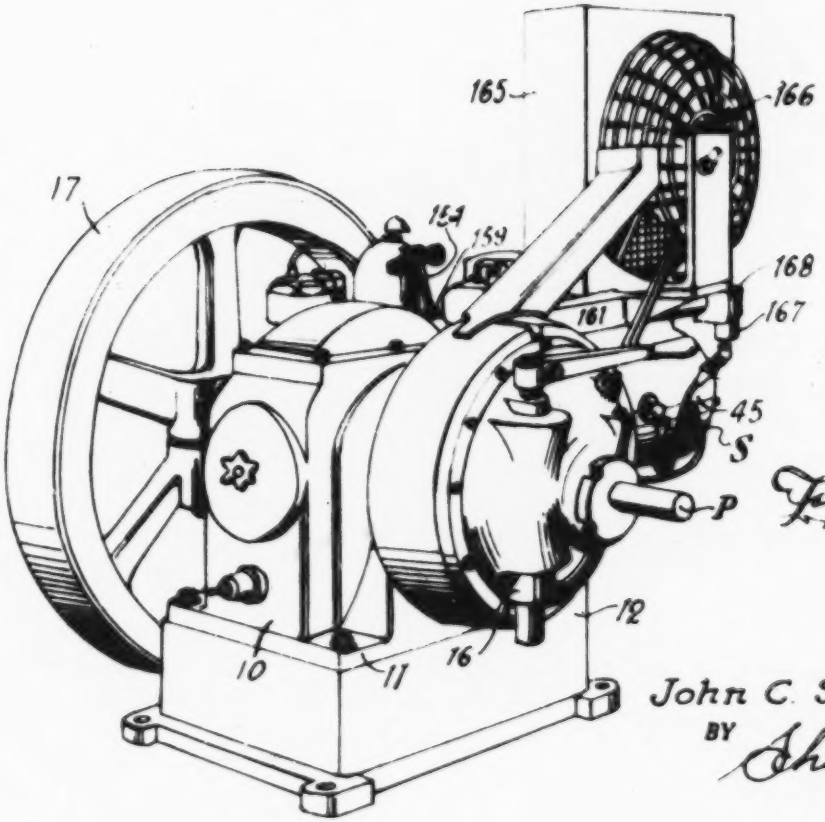

Fig. 2

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INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 2

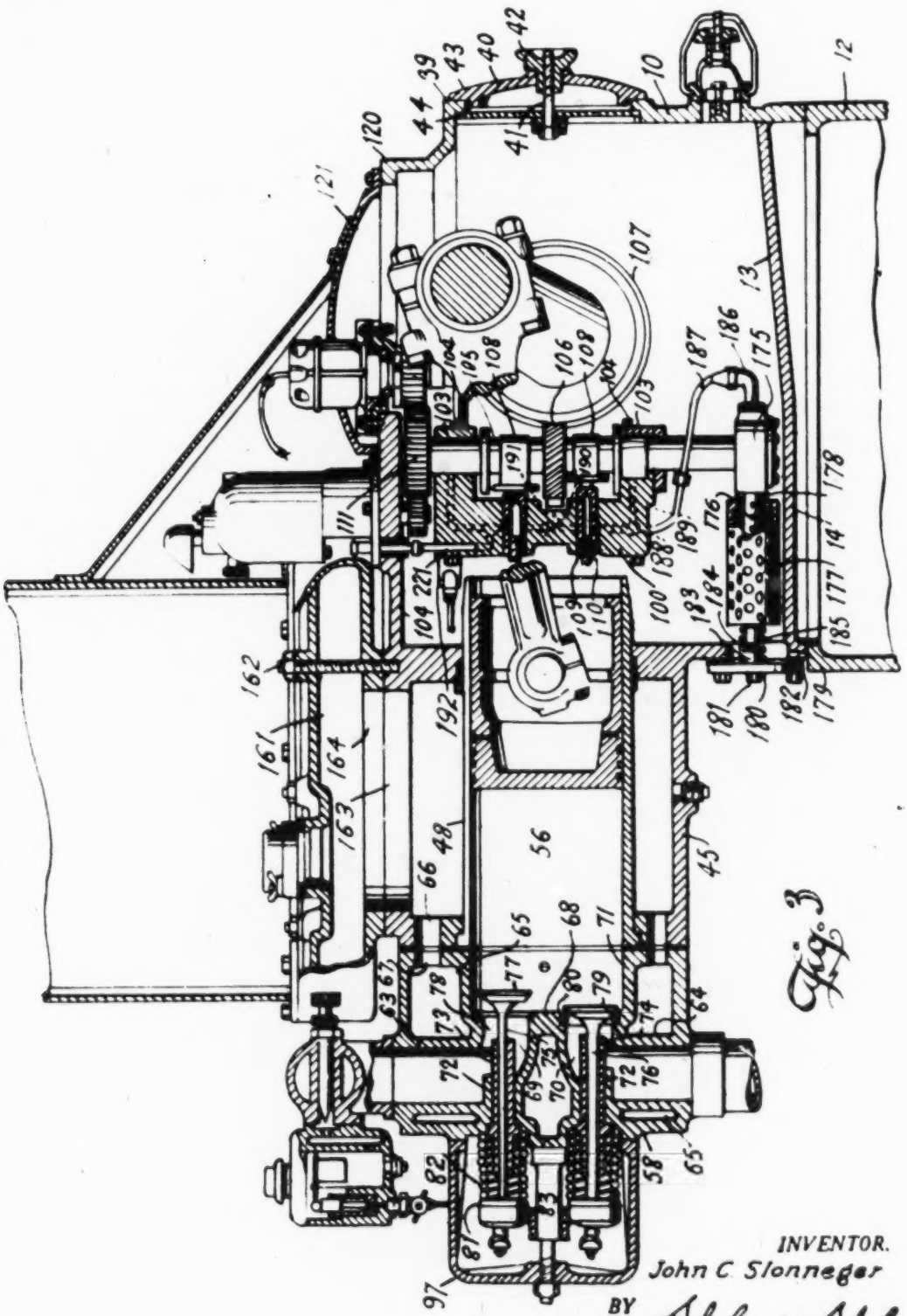

Fig. 3

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INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 3

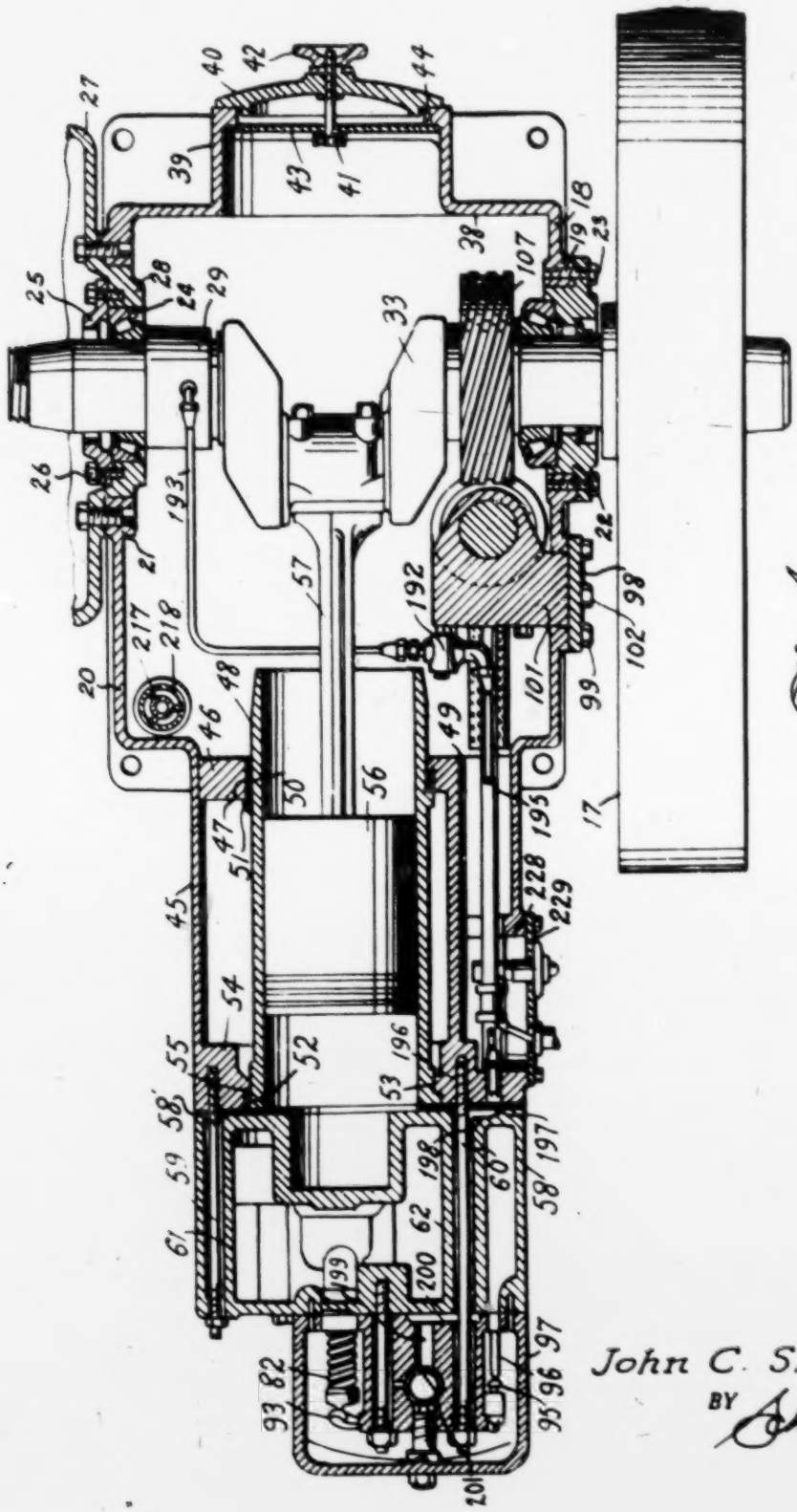

Fig. 4

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INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 4

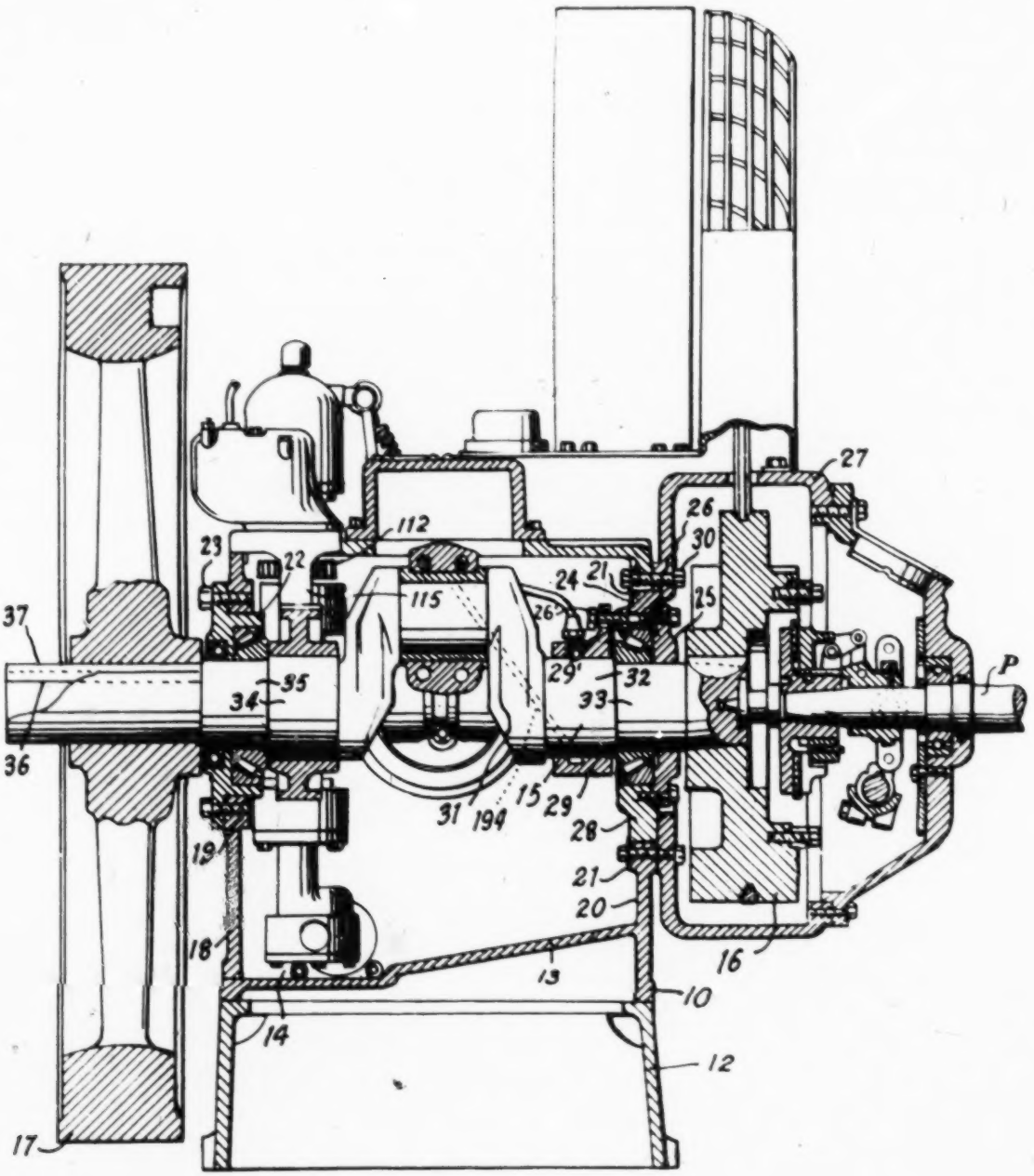

Fig. 5

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INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 5

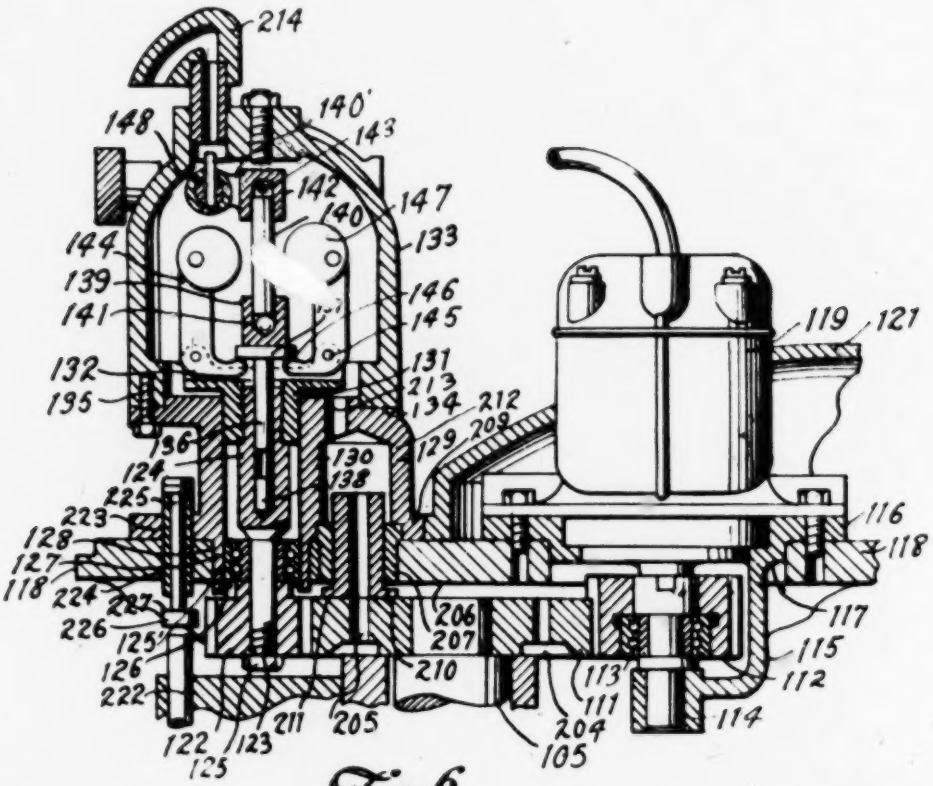

Fig. 6

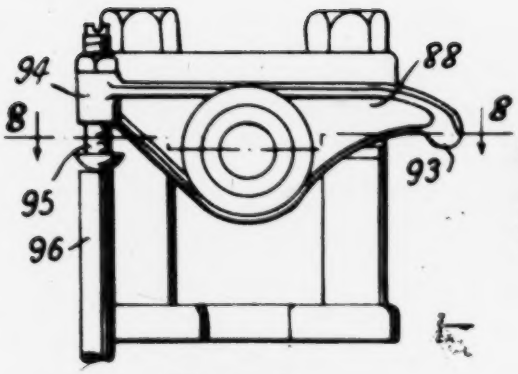

Fig. 7

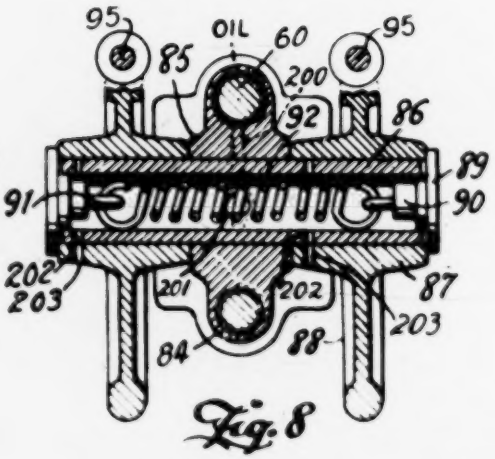

Fig. 8

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March 25, 1952 J. C. SLONNEGER 2,590,134

INTERNAL-COMBUSTION ENGINE

Filed March 14, 1946 7 Sheets-Sheet 6

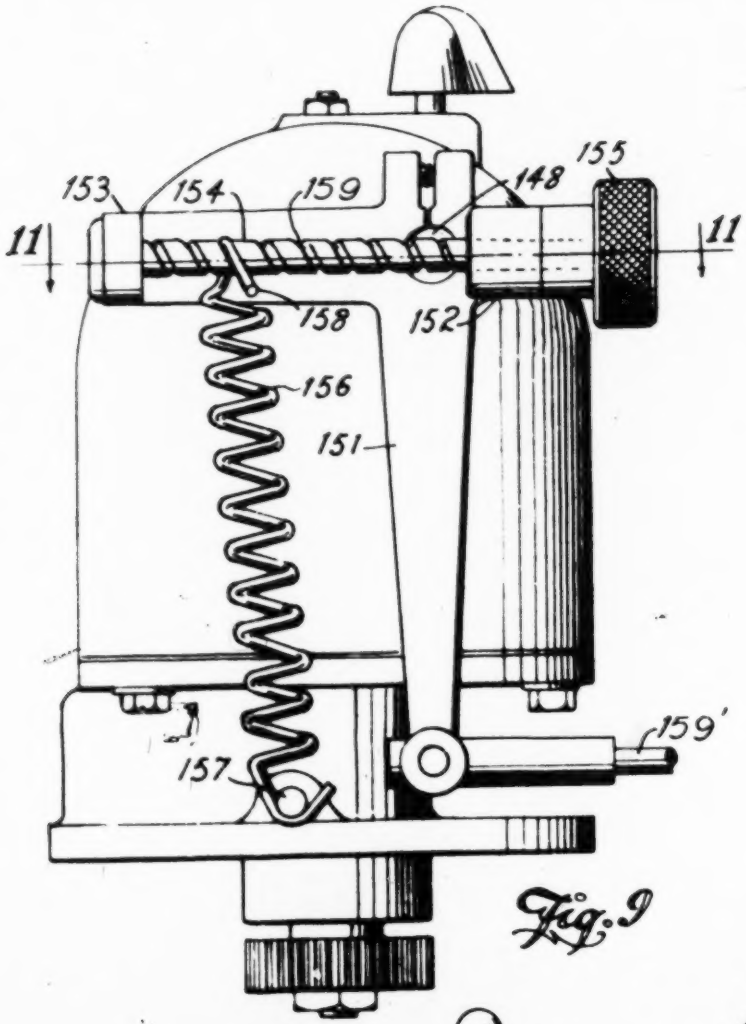


Fig. 9

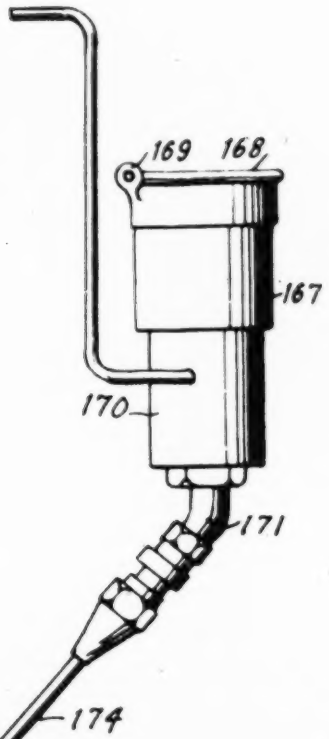
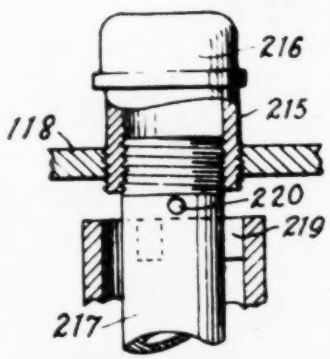


Fig. 10



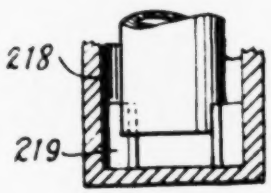


Fig. 12

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March 25, 1952 J. C. SLONNEGER 2,590,134

INTERNAL-COMBUSTION ENGINE

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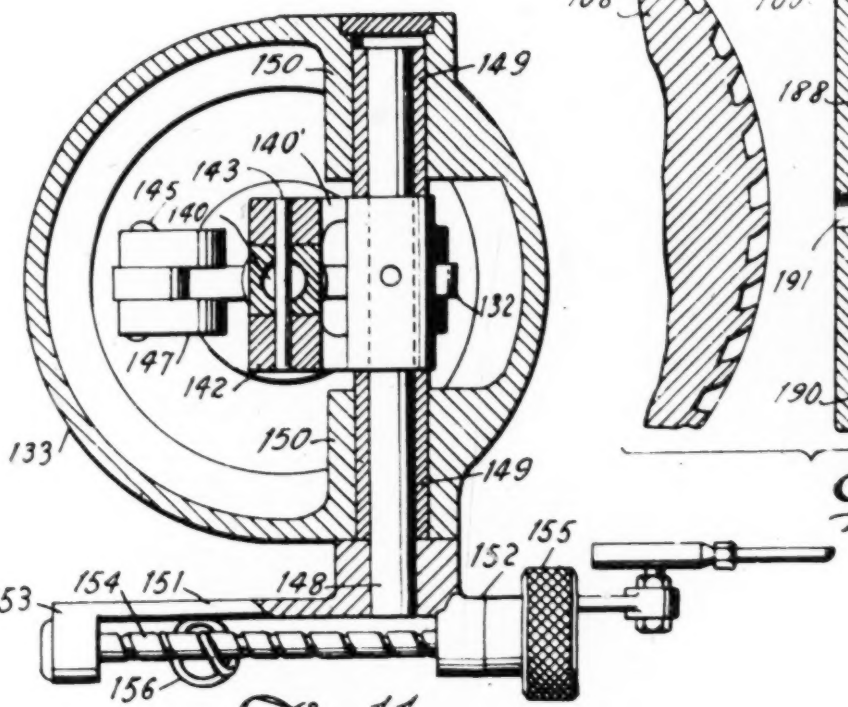

Fig. 11

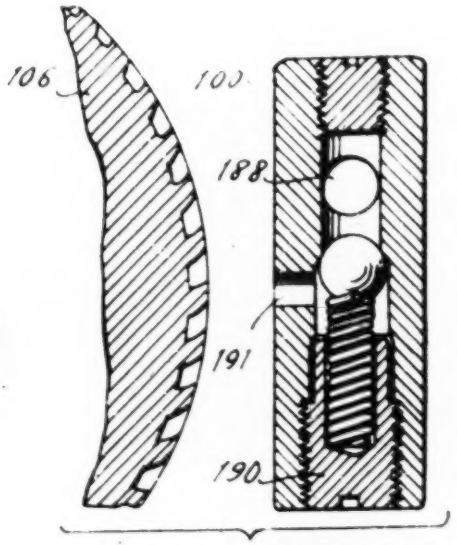

Fig. 16

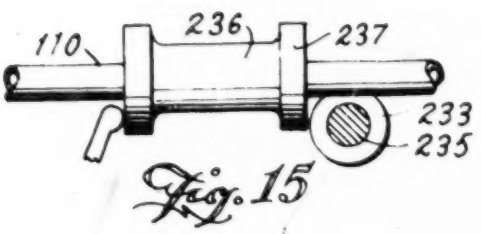

Fig. 15

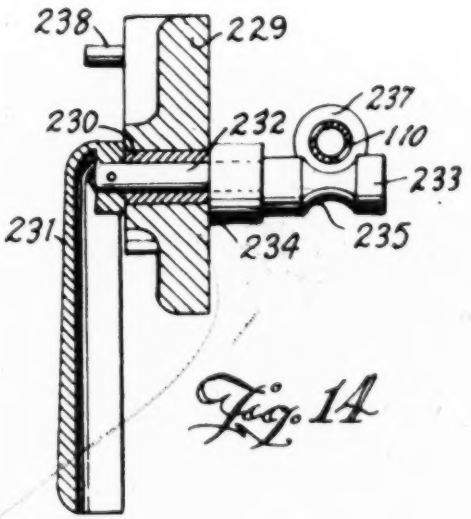

Fig. 14

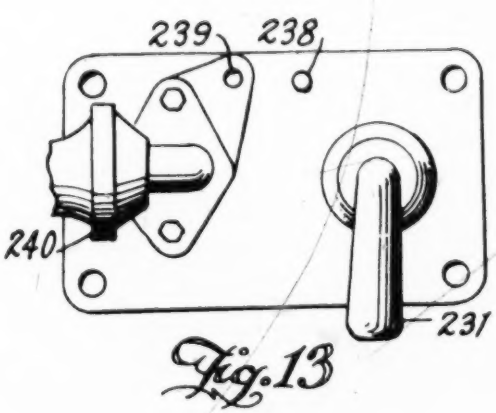

Fig. 13

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2,590,134

INTERNAL-COMBUSTION ENGINE

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Application March 14, 1946, Serial No. 654,427

13 Claims. (Cl. 123—195)

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This invention relates to new and useful improvements in internal combustion engines.

One object of the invention is to provide an improved engine of the single cylinder type which among other uses is particularly adapted for driving pumping equipment and which possesses features making for longevity and low maintenance.

Another object of the invention is to provide an improved engine wherein the various elements are arranged for simple and ready installation as well as for accessibility.

A further object of the invention is to combine in the engine a simple and efficient lubricating system which not only assures adequate lubrication of the various moving parts, but which reduces to a minimum the number of pipes and couplings; as well as providing a simple and positive means of ascertaining the oil pressure without the use of delicate gauge mechanism.

Still another object of the invention is to provide an engine having improved means for relieving compression to make for easy and ready starting.

A further object of the invention is to provide an improved engine having a governor which maintains a steady throttle, which will produce substantially uniform power strokes and whereby, variations in speed of the engine cause the flywheel to store and give up energy at the right time and substantially at the exact moment and in the required amounts for smooth and satisfactory operation, means being included in the engine for lubricating the governor in a new and novel manner.

Another object of the invention is to provide an engine having an improved governor which is quickly and readily adjusted accurately without tools to any desired speed within its range which is very wide, said governor having substantially the same sensitivity throughout its range and being constructed so as to eliminate trouble caused by dirt and extraneous matter entering the adjusting mechanism.

A still further object of the invention is to provide an engine having improved lubricating oil filler means which effectively seals the crankcase and yet allows the ready addition of lubricating oil while the engine is running or while it is idle, said engine incorporating means for venting the crankcase at proper intervals in the cycle of operation and for preventing loss of lubricating oil through said venting means.

Yet another object of the invention is to provide an engine wherein simple and effective

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means are furnished for determining the water level in the cooling jacket of the engine while the engine is running or idle, said means allowing the addition of water at any desirable time and providing for the automatic disposal of excessive quantities of water whereby priming of the radiator is eliminated.

A further object of the invention is to provide an engine having an improved oil collecting ring for the crankshaft which is full-floating and substantially free from wear and oil leakages caused thereby.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein an example of the invention is shown, and wherein:

Fig. 1 is a side elevation of an engine constructed in accordance with the invention,

Fig. 2 is an isometrical view of the same, taken from the side opposite to that shown in Fig. 1,

Fig. 3 is a longitudinal sectional view of the engine,

Fig. 4 is a horizontal cross-sectional view of the same,

Fig. 5 is a transverse sectional view taken through the vertical plane of the crankshaft,

Fig. 6 is a transverse sectional view of the governor and magneto mounting,

Fig. 7 is a detail of one of the rocker arms and the mounting therefor,

Fig. 8 is a horizontal cross-sectional view taken on the line 8—8 of Fig. 7,

Fig. 9 is an enlarged side elevation of the governor showing the regulating means,

Fig. 10 is an enlarged side elevation of the water filling assembly,

Fig. 11 is a horizontal cross-sectional view taken on the line 11—11 of Fig. 9,

Fig. 12 is a view partly in elevation and partly in section of the oil filler assembly,

Fig. 13 is an elevation of the fuel pump mounting plate, showing the compression releasing lever,

Fig. 14 is an enlarged vertical, sectional view showing the position of the lever with respect to the intake valve push rod,

Fig. 15 is a partial view in elevation of the spool secured on the intake push rod for engagement by the lever, and

Fig. 16 is a horizontal, cross-sectional view of

the center portion of the camshaft block, showing the oil pressure relief valve.

In the drawings, the numeral 10 designates a hollow crankcase which is provided with external horizontal lugs 11 at its corners whereby the crankcase may be bolted upon a hollow base 12 or secured upon any other support. The crankcase, as is best shown in Figs. 3 and 5, is provided with a false bottom 13 which inclines toward a sump 14 at one side thereof. The crankcase has a crankshaft 15 extending transversely therethrough and connected at one end with a clutch designated generally at 16 on the clutch side of the engine or crankcase. A power take-off shaft P is suitably connected into the clutch mechanism. A flywheel 17 is mounted on the opposite end of the crankshaft on the flywheel side of the engine or crankcase. Flywheels on this type of engines are usually provided with comparatively heavy rims so as to aid in maintaining momentum.

While the crankshaft may be suitably mounted in the crankcase, I prefer to form the wall 18, which is on the flywheel side, with an integral annular collar 19 and to provide the opposite wall 20, which is on the clutch side, with an integral annular collar 21. Although the crankshaft 15 is supported in axially alined bearings, and the collars 19 and 21 are axially alined, they are of different diameters. A roller bearing assembly 22 is secured in the collar 19 by bolts 23.

The clutch 16 includes a cylindrical hollow casing 27. This casing is formed on the inner side of its medial portion with an outwardly offset annular hollow boss 28 which is inserted in the collar 21, and a roller bearing assembly 24 is mounted in this boss. The bearing assembly 24 is confined within the boss by a retaining ring 25 secured on the outer side of the boss by tie bolts 26. An annular lubricant collector 29 is secured against the inner end of the boss in the crankcase by a stud bolt 26' which engages a perforate ear 29' formed on one side of the collector. It will be noted that the opening in the ear 29' is oversize and the head of the bolt 26' does not engage the face of said ear. Thus, the collector 29 is loosely held against rotation only, and is free to move with the crankshaft which it encircles. This structure protects the collector against lateral thrust of the crankshaft which might be caused by wear or misadjustment of the bearing assembly 24, and thereby prevents wear of the collector with the consequent leakage of lubricant. The only load which can be placed on the collector is that represented by its own weight, which is small.

The clutch case 27 is secured to the collar 21 by bolts 30. The crankshaft 15 is provided with the usual crank 31 at its medial portion and is stepped on each side thereof to provide annular bearing faces 32, 33 and 35, respectively, and an annular gear-mounting face 34 on the flywheel side, between the crank and the face 35. The face 32 has a turning fit in the collector 29 while the face 33 is supported in the bearing assembly 24 and extends through the ring 25. The face 35 is supported in the roller bearing assembly 22. Outwardly of the face 35, the end of the crankshaft is provided with a key seat 36 receiving a key 37 whereby the flywheel is secured on said shaft.

The outer end wall 38 of the crankcase is provided with an outwardly-extending annular sleeve 39 which forms a hand-way. A dished cover 40 is attached to the outer end of the sleeve by means of a central bolt 41 and hand nut 42. The head of the bolt is secured in a bar 43 which has either end engaging an annular shoulder 44 within the sleeve, whereby the cover is removably fastened on the crankcase opposite the crankshaft.

The inner end of the crankcase is extended to form a cooling jacket 45 which is considerably less in cross-sectional area than the crankcase proper. Near its inner end, the jacket is formed with an internally transverse web 46 which has a cylindrical opening 47 for snugly receiving one end of a piston cylinder or liner 48. The opening 47 is counterbored at 49 to receive a packing ring 50 which snugly embraces the cylinder. The inner end of the cylinder projects slightly into the crankcase as is best shown in Figs. 3 and 4. The cylinder is formed with an annular bead 51 which engages the packing ring 50 and forces it into the counterbore 49 as well as holding it in place. The outer end of the cylinder is provided with an external annular flange 52 and an annular boss 53 extending inwardly from said flange and of less diameter than said flange. At the outer end of the jacket, an annular abutment 54 is formed in the jacket 45 and provided with an annular internal seat 55 complementary to the flange and boss to snugly receive the same. The parts which have been described support the cylinder in proper position to receive a piston 56 connected to the crank 31 by means of a suitable connecting rod 57. The cylinder is removable and may be withdrawn from the jacket for any purpose.

This engine is of the valve-in-head type and, therefore, a cylinder head 58 is mounted on the outer end of the jacket 45 and secured to the abutment 54 by stud bolts 59 and 60. It will be observed that the outer faces of the abutment and cylinder are flush and the inner face of the head is likewise flush so that a head gasket 58' may be secured therebetween to form a fluid-tight joint. The head 58 is generally hollow and provided with passages and ducts, which will be hereinafter described. The bolts 59 and 60 extend loosely through sleeves 61 and 62, respectively, within the head and made integral therewith. The head 58 is cast with a vertical intake duct 63 in its upper portion and a vertical exhaust duct 64 in its lower portion. These ducts are spaced from the vertical walls of the head so as to provide a circulating space 65 therearound, as is common in this art, and this space communicates with ports 66 in the abutment 54 through ports 67 in the face of the head. A coolant supplied to the jacket 45, may thus circulate through the head. The inner ends of the ducts 63 and 64 are made integral with a valve block indicated generally by the numeral 68. The inner ends of the ducts merge into inwardly-directed elbows or passages 69 and 70 (Fig. 3). These passages communicate with an annular cylinder chamber 71 formed integral with the head 58 and alined with the cylinder 48.

The valve block 68 is formed with transverse counterbored openings 72 at the inner ends of the ducts for receiving flanged bushings 73 for valve stems 75 and 76 respectively. An intake valve 77 fastened on the inner end of the stem 75 engages an annular seat 78 at the inner end of the passage 69; while an exhaust valve head 79 engages an insert seat 80 countersunk in the inner end of the passage 70. The valve 77 controls the intake of fuel to the cylinder; while the valve 80 controls the exhaust from the cylinder. The outer

ends of the valve stems carry collars 81 and coil springs 82 are confined between these collars and the bushings in the usual manner; such springs being under sufficient tension to hold the valves on their seats.

A split rocker bracket 83 is removably secured on the outer end of the head 58 and held in place by the bolt 60 which passes through one side thereof and at its opposite side, by a bolt 84 (Fig. 4) which is screwed into the head. This bracket is formed with an integral and enlarged bearing collar 85 through which a tubular rocker shaft 86 extends. The shaft is clamped in the collar and on each side of the collar the hubs 87 of a pair of rocker arms 88 are rotatably mounted, as shown in Figs. 7 and 8. These arms are retained on the shaft by cap plugs 89 bearing against the ends of the shaft and having stepped shanks 90 which carry hooks 91 connected with the ends of a coiled springs 92, which latter acts to hold the caps in engagement with the ends of the tubular shaft.

Each rocker arm carries a curved rocker 93 at one end and an integral tappet sleeve 94 at its opposite end. The rockers 93 engage the upper ends of the valve stems 78 and 78 in the usual manner for depressing the same, and this particular structure is not an essential part of the invention. In each tappet sleeve, a tappet pin 95 of the usual construction is adjustably mounted for operation by push rods 96. A cover housing 97 is removably mounted on the head for enclosing the rocker mechanism.

One of the important features of the invention resides in the camshaft and lubricating unit which is mounted in the crankcase and includes a hanger block 100. This block is disposed vertically on the flywheel side and attached to a cover plate 98 secured on the vertical wall of the casing by bolts 99, whereby an opening 101 is left in the side wall. The inner face of the plate 98 is machined to provide a proper mounting for the block 100, and the obtaining of such a mounting is the reason for utilizing the mode of structure, the machining of an interior wall of the crankcase being undesirable. The block is attached to the cover plate by bolts 102. At each end of the block, solid bearing boxes 103 are fastened by bolts 104. A camshaft 105 is journaled in these boxes and a pinion 106 fastened on the medial portion thereof. This pinion is driven by a gear 107 fastened on the face 35 of the crankshaft 15. The gear and pinion are of the spiral type and are disposed in planes at right angles to each other.

On each side of the pinion and between the boxes, cams 108 are provided and the throws of these cams are disposed in the proper angular adjustment for actuating valve lifters 109 attached to the push rods 96 which extend through the jacket 45 and engage the tappets 95 on the ends of the rocker arms 88 and thus, when the crankshaft is revolved, rotation is imparted to the gear 107 and pinion 106, whereby the camshaft is rotated and the rocker arms 88 are actuated to alternately depress the inlet and exhaust valves.

The camshaft 105 extends from the upper end of the block and has fastened thereon a gear 111. This gear drives a magneto pinion 112 as is shown in Fig. 6. The pinion 112 is disposed horizontally and mounted on a ball bearing assembly 113 carried by a shaft 114 supported in a depending bearing bracket 115 which forms part of a magneto base 116 which is bolted in an opening 117 on the top wall 118 of the crankcase. A magneto 119 which may be of any approved construction is secured on this base, and is connected to a suitable spark plug 8 mounted in one wall of the head 58. The top wall 118 of the crankcase is provided with an opening 120 which is closed with a dome-shaped cover 121 to allow proper clearance for the throw of the crankshaft.

Diametrically opposite the pinion 112, the gear 111 meshes with a governor pinion 122. This pinion is fastened on the reduced shank 123 of a tubular governor shaft 124 by means of a nut 125. At the intersection of the shank and the tubular portion of the governor shaft, a horizontal ball bearing assembly 126' is provided for rotatably supporting said shaft. The bearing assembly is mounted in a collar 127 and held in place by a retaining ring 126. The collar fits in a circular opening 128 formed in the top plate 118 of the crankcase and depends from the bottom of a governor base 129 which is bolted on said top plate. The governor shaft is enclosed within a sleeve 130 formed at one side of the base and integral therewith. The upper end of the shaft is reduced and has fastened thereon a bearing collar 131 which rotates in the upper end of the sleeve and extends thereabove. A transverse grooved bracket 132 is made integral with the upper end of the collar.

A dome-shaped governor housing 133 is secured in an annular recess 134 in the top of the housing by means of bolts 135. The shaft 124 terminates below the upper end of the collar 131 and receives a vertically slideable plunger 136. This plunger carries a thrust disk 137 on its upper end. The lower end of the plunger carries a piston 138 which has a loose sliding fit in the bore of the tubular governor shaft. The piston operates in an oil bath which lubricates the plunger and damps its action. A cylindrical cup 139 is mounted axially of the plunger on the disk 137 and receives the lower end of a detent 140 which rests upon a ball 141 in said cup. The upper end of the detent engages in an inverted cup 142.

Since the governor shaft 124 is rotatable, the collar 131 and the bracket 132 are likewise rotatable; the bracket rotating in the lower portion of the governor housing and the plunger 136 being slideable therethrough. Angular governor arms 144 are mounted in the grooved ends of the bracket on pins 145 and have inwardly-directed fingers 146 which engage between the disk 137 and the bottom of the bracket. Weights 147 disposed on the upper ends of the arms overhang the fingers and tend to swing the arms toward the detent 140. The governor arms work in the usual manner, whereby the weights are displaced outwardly as the speed of rotation increases, whereby the plunger 136 is elevated which carries the cup 139 and the detent 140 upwardly.

The upper cup 142 is pivoted by a pin 143 to an arm 143' formed on one side of an operating shaft 148 which is journaled in bearing sleeves 149 extending through bosses 150 in the upper portion of the housing 133. The operating shaft extends through one side of the housing and has clamped thereon a crank arm 151. This crank arm has spaced ears 152 and 153 at its upper horizontal end in which a spiral shaft 154 is journaled. A knurled knob 155 is fastened on one end of the shaft for rotating the same. A coiled spring 156 has its lower end engaged over a stud 157 on the exterior of the governor base 129. The upper end of the spring is formed into a hook 158 which is engaged in the spiral groove 159 of the shaft 154.

It will be observed that when the governor shaft 124 is revolved and the arms 144 displaced outwardly, the disk 137 will be lifted, and consequently the detent 140 and cup 142 will swing the arm 143' whereby the operating shaft 148 will be rocked which, in turn, will rock the crank arm 151. By this arrangement, the amplitude of the swing of the long leg of the crank will be controlled by the centrifugal action of the governor. Further, it will be seen that the tension of the spring 156 exerts a downward pull or force not only upon the crank, but upon the plunger 136 through the elements connected therebetween. The pull of the spring 156 is reflected in leverage determined by the spacing of the hook 158 from the shaft 148 on which the crank is fastened. If the knob 155 is turned to move the hook 158 closer to the shaft 148, this leverage is reduced, but if the rotation of the shaft is reversed to move the spring hook outwardly, then the leverage is increased; also as the hook 158 is moved outwardly on the shaft, the spring will be adjusted at an increasing angle to the perpendicular, and therefore, its tension will be increased. The lower end of the crank 151 is pivotally connected to a throttle rod 159' which is suitably attached to the throttle of a carburetor 160 mounted on the cylinder head and connected with the intake passage 63 in the usual manner. The carburetor may be of any desirable type and structure.

The forces exerted by the centrifugal action of the governor and the extension of the spring 156 seek a balance. An increase in speed will raise the plunger 136 and if this occurs suddenly, a partial vacuum will be produced below the piston 138 because of the comparatively slow by-passing of the oil balance confined in the governor shaft. This vacuum, of course, slightly retards the action of the governor and momentary slight overspeeding may result. If the increase in speed is maintained, the plunger will be further elevated as the oil completely fills the bore below the piston and thus relieves the force of the partial vacuum of the plunger. Now if the speed should be suddenly decreased, the plunger can move downwardly only as rapidly as the unbalanced force acting downward causes the piston to by-pass the oil trapped thereunder. By controlling the clearance between the piston and the bore of the governor shaft, the rate at which the oil by-passes is regulated and thus, upon the downward motion of the plunger, a greater retarding or damping action may be obtained than during the upward motion thereof. It is, of course, understood that the governor is so connected to the throttle of the carburetor that an upward motion of the plunger 136 causes the throttle to move toward a closed position and upon a downward movement of the plunger, to move toward an open position. In view of the foregoing, it is pointed out that because of the damping or retarding action, the throttle may be closed quickly, thereby preventing the engine from overspeeding, but the throttle cannot be opened as rapidly. In all speed changes, the piston 138 exerts a damping action to steady the speed of the engine.

Where the engine is used with a comparatively rapidly fluctuating load, as for instance where an oil well pump is being driven, the damping action has the effect of producing substantially no movement of the throttle valve, since the governor assumes substantially an average position due to the fact that the governor does not react to momentary speed changes, as will be obvious from the foregoing description. Should the average load be definitely changed, the spring and governor weights will slowly assume a new average position to maintain balance, but it is pointed out that if the change of load or speed is of short duration, there may be substantially no change in the position of the throttle. In ordinary governors, the mechanism is so constructed that a sudden reduction in speed will cause the governor weights to collapse, which will result in a sudden opening of the throttle. However, the damping action herein described avoids this condition and the throttle will open in a comparatively even and steady manner. It is pointed out that the sensitivity of the governor is not impaired by this oil damper. On the contrary, the arrangement of the spiral shaft 154 and spring 156 provides for very accurate adjustment as to speed which the governor will maintain under rapidly fluctuating loads.

The knob 155 provides a convenient means for adjusting the governor for predetermined speeds and such adjustment provides for a very broad speed range. As has been before pointed out, this is due to the leverage effect of the spring 156 on the crank 151. By this arrangement, a wide range of speed adjustments may be accomplished and the sensitivity proportionately maintained.

To provide for cooling the engine, a flat tank 161 is secured on the jacket 46 by means of bolts 162. In the upper side of the jacket, an opening 163 registers with an opening 164 in the bottom of the tank, and thus a coolant such as water is supplied to the jacket and may flow therefrom through the openings 66 and 67 into the cylinder head 58 wherein it may circulate through the passages 65. A suitable vented radiator 165 is mounted on the tank and provided with a fan (not shown) enclosed in a guard 166 for drawing air through the radiator and cooling the same. The details of the cooling system are not essential to the engine, except as herein pointed out.

In the horizontal type of engine, steam or vapor cooling readily adaptable. However, one of the difficulties has been the determination and maintenance of a proper water level in the system. If the water level is too high, a boiling turbulence will cause the water to be thrown into the radiator tubings and result in priming. Too low a level will cause overheating. The agitation of the water renders the ordinary means of determining the true water level unreliable. The common practice has been to determine the water level after the engine has been stopped and boiling has ceased. Obviously, it is unsatisfactory and impractical to stop the engine to check the water level.

To overcome this difficulty, I attach to the outside of the tank 161 (Fig. 2) a cup 167 having a loose fitting lid 168 which while held closed by a spring hinge 169, is nevertheless nonsealing. The cup has a reduced depending tubular portion 170 into the bottom of which a 45° elbow 171 is fastened. An elbow 172 is screwed into the side of the jacket 46 on substantially the plane of the transverse axis of the engine piston 56 which is substantially the medial portion of said jacket. A U-shaped tube 173 is suitably connected with the elbow 172 and the upper end of the tube is merged into an extension 174 which is suitably connected with the elbow 171. It is obvious that the water level in the jacket 46

will be the same as the water level in the tubes 173, 174 and the cup 187 since both the radiator and the cup are vented to the atmosphere. The cup is of such length that its lower end corresponds to the minimum level of the water in the jacket which is deemed safe for operation, while the top of the cup is at such an elevation that it corresponds to the highest water level that may be maintained without causing objectionable surging of the steam or vapors in the radiator tubes.

It will be apparent that so long as water appears in the cup, the engine may be safely operated so far as its cooling is concerned. An abnormal rise in the water level due to expansion or displacement by steam above the level of the top of the cup or by the addition of excessive amounts of water to the cooling system will cause the water to overflow the cup since the lid 188 is not sealed. Because of the inertia of the column of water in the tube 173, variations in pressure due to the turbulence of boiling will not cause objectionable movement of water in the cup. One purpose of forming the tube in a U-shape is to prevent thermosyphonic circulation of the water between the jacket and the cup. Since water is a comparatively low conductor of heat, such water as remains in the cup will be comparatively cool, thus preventing water loss by excessive evaporation or the loss of antifreeze solution when the same is used. Water may be added by pouring the same into the cup when the engine is running or when the engine is idle. The cup and the radiator being vented to the atmosphere, the vapor pressure in the cooling system never exceeds that of the atmosphere.

The lubricating system of this engine is designed and constructed to be as efficient and yet as simple as possible, with a minimum of oil lines and feeders, the basic parts of the engine being utilized to conduct the lubricating oil rather than separate pipes. The lower end of the camshaft 106 is extended and connected to a suitable oil pump 176 positioned near the bottom of the crankcase and having its inlet pipe 176 arranged to pick up lubricating oil from the sump 14. A suitable screen or filter 177 which may be of any desirable type, has a sliding fit over the inlet pipe 176 and engages a gasket 178 disposed at the inner end thereof. The filter, of course, serves to prevent dirt and foreign matter from entering the pump 176 and the balance of the lubricating system. To allow ready servicing and replacement of the filter 177, an opening 179 is formed in the vertical wall of the crankcase adjacent the end of the filter, and is adapted to be closed by a plate 180 held by suitable machine screws 181. A gasket 182 seals the joint between the plate 180 and the crankcase wall. The plate is provided with a centrally-located boss 183 on its inner face and a stud bolt 184 is secured therein. The bolt 184 has a close sliding fit within an opening in the outer end of the filter and has a nut secured to its inner end whereby the filter is slideably secured to the plate 180. A coiled spring 185 is compressed between the plate and the filter so that when the plate is in place, the filter is urged inwardly into engagement with the gasket 178. Obviously, removal of the plate 180 allows the quick and easy removal of the filter through the opening 179 for cleaning or replacement.

The pressure outlet 186 of the oil pump 176 is connected by a pipe 187 to the lower end of an axial oil passage 188 formed in the block 100. Lateral passages 189 communicate with the passage 188 and direct lubricating oil onto the bearing surfaces of the camshaft 106. An oil relief valve 190 is mounted in the medial portion of the block 100 so as to communicate with the passage 188. The valve 190 is of the usual adjustable spring-loaded type and discharges through an opening 191 directed through the block 100 toward the pinion 108 secured on the camshaft. Thus, oil passing through the valve is caused to flow upon the pinion 108 and thereby lubricate this pinion and the gear 107 disposed on the crankshaft.

An oil outlet fitting 192 is mounted in the upper end of the block 100 and has connected in one side thereof an oil pipe 193 extending through the crankcase to the oil collector ring or collar 28. The face 32 is provided with an opening 194 which extends through the crankshaft in the usual manner to provide lubrication for the connecting rod bearing and the bearing face 36. If desired, oil may also be conducted to the wrist-pin bearing of the connecting rod.

A second oil pipe 195 extends outwardly from the fitting 192 and connects into an opening 196 formed in the abutment 84 and registering with a similar opening 197 in the gasket 86'. A milled groove 198 extends laterally of the sleeve 82 so as to communicate with the opening 197, whereby lubricating oil may flow from the pipe 195 through the openings 196 and 197 and the groove 198 to the annular space around the bolt 90, and thus to the outer end of the head 88. The gasket 86' effectively seals this connection.

It is pointed out, that the sleeve 82 is surrounded by the water jacket wherein a temperature approaching 212° F. exists. Thus, the sleeve acts as a heat exchanger to warm the oil flowing therethrough and thereby maintain a higher oil temperature throughout the lubricating system. In engines of this type, and especially in colder climates, this result is desirable since oil temperatures usually are too low for efficient lubrication.

The bracket 83 is formed with a passage 199 extending inwardly from the bore of the collar 85, and a groove 200 communicating between the upper end of the collar 82 and the passage 199 to lubricate said bore. The tubular rocker shaft 86 is provided with central radial openings 201, whereby oil under pressure may enter the bore of said shaft and be conducted thence to openings 202 formed in each end of the shaft. Ports 203, similar to the openings 202, are formed in the hubs 87 of the rocker arms 88, and are so positioned as to register with the openings 202 when the valves 77 and 78 are in open positions. The ports 203 are so directed as to throw a stream of oil on the exposed portions of the valve stems whereby efficient lubrication is maintained. Thus, intermittent lubrication of the valve stems, and continuous lubrication of the rocker arms and the rocker arm shaft is assured.

It is pointed out, that this lubricating system for the valve and rocker arms does not require the use of separate oil lines which are subject to damage and leakage, and possibly may be incorrectly connected by a person working on the engine, or not connected at all. The oil lines form an integral part of the rocker bracket and the cylinder head and are removed and replaced when these elements are.

The crankcase is vented in a manner which prevents loss of oil by breathing and at the same time lubricates the governor mechanism. The venting structure is best shown in Fig. 6 of the

drawings. The gear 111 fastened on the upper end of the camshaft 105 is formed with a concentric groove 204 in its lower face and diametrically-opposed openings 205 extending upwardly therefrom through the gear. Obviously, the openings 205 are in communication at all times with the crankcase. An opening 203 is provided in the top wall 118 of the crankcase immediately above one side of the circular path traveled by the openings 205 so as to alternately register with said openings as the gear 111 rotates.

A bushing 207 has a close fit in the opening 206. The bushing carries an annular flange 208 on its upper end so as to support the bushing within the opening and engages within a recess 209 formed in the lower face of the governor base 126, whereby the bushing is securely held. A nipple 210 rests upon the upper face of the gear 111 and rides within the bushing, the lower end of the nipple being flanged to prevent its upward displacement through the bushing. Normally, there is space between the flange and the bushing, the close fit between the latter and the nipple preventing leaks therebetween. An enlarged chamber 212 is formed in the base 126 above the recess 209 and a port 213 communicates between the chamber and the interior of the governor housing 189. The upper end of the governor housing is vented to the atmosphere through a suitable vent cap 214.

As the engine is operating, the movement of the piston within the cylinder will cause a variation in volume and a consequent variation in pressure within the crankcase. As the gear 111 rotates, the openings 205 will come into alternate register with the nipple 210 and thus vent to atmosphere through the governor housing. As air, with entrained oil, passes through the nipple and enters the enlarged chamber 212, and again as it enters the enlarged interior of the governor housing, its velocity is reduced and the oil flung out against the wall of the governor housing by the governor weights so as to return to the crankcase via the space around the shaft 124 and the nipple. This oil serves to lubricate the governor mechanism, and to some extent to replenish the oil within the oil damper of the governor.

The openings 205 are so spaced on the gear 111 as to register with the nipple 210 when the piston is at bottom dead center. The total opening and closing period represents about 30° of crankshaft rotation so that during the major portion of a cycle the vent is closed, and the crankcase is under partial vacuum whereby the return of oil from the governor housing is aided.

A special assembly is utilized for adding lubricating oil to the crankcase. This assembly is shown in Fig. 12, and is positioned vertically in one corner of the crankcase as is shown in Fig. 4. The assembly comprises a collar 215 secured in the top wall 118 of the crankcase and adapted to be closed by a suitable cap 216. An elongate nipple 217 extends downwardly from the collar, while a sleeve 218, having its lower end closed, telescopes the nipple 217 and has its open upper end disposed a short distance below the top wall 118. Spacers 219 are positioned in the annular space between the nipple and the sleeve at the top and bottom thereof, and being welded or otherwise suitably secured to both elements, serve to secure them together as well as space their sidewalls.

Lubricating oil, upon introduction into the collar 215, flows downwardly through the nipple and then, as additional oil is added, upwardly through the annular space between the nipple and the sleeve 218 until it overflows the upper end of the sleeve and enters the crankcase. The oil will flow thus until the head in the nipple equals the head in the sleeve. Oil will remain in the annular space so that an oil seal is established which effectively seals the crankcase and allows the addition of oil while the engine is running or while it is idle. The turbulence and splashing of oil, normal in the crankcase of an engine in operation, is not communicated to the oil filler pipe so that oil may be readily added, and air may not be drawn into the crankcase because of the oil seal.

It has been found that in actual operation at a fairly uniform speed, the oil columns within the nipple and sleeve tend to fluctuate due to variable pressures within the crankcase, and such fluctuations reach amplitudes at times sufficient to splash most of the oil into the crankcase whereby the oil seal is lost. To prevent this occurrence, a small hole 220 is formed in the wall of the nipple 217 above the upper end of the sleeve 218 so that pressure equalization may take place. The hole 220 is small so that air breathed into the crankcase is kept at a minimum.

An improved means for determining oil pressure has been provided. The upper end of the block 100 is formed with an upwardly-extending passage 221 communicating with the passage 188, and counterbored to receive a cylindrical plunger 222, which has a sliding fit within the counterbore. Since the oil pressure exerted by the oil pump is directed against the lower end of the plunger, the plunger will react to such pressure to move longitudinally within the counterbore. A bushing 223 is secured within an opening 224 formed directly above the plunger in the top wall 118 of the crankcase and the flanged base 126 of the governor unit. A feeler rod 225 has a sliding fit within the bushing and is provided with flanged caps 226 at either end to retain the rod within said bushing. The lower cap is adapted to be engaged by the plunger 222 so as to move the rod upwardly as the plunger moves thus. A packing ring 227 is confined on the inner side of each of the caps 226 so as to seal the space between the rod 225 and the bushing 224 when the rod is in its upper or lower position.

When the engine is in operation, the pressure exerted by the oil pump forces the plunger 222 and thus the rod 225 upwardly. Manual pressing down of the feeler rod must overcome this pressure, and thus will indicate to the operator the amount of oil pressure being developed. This pressure gauge is reasonably accurate, and is almost entirely free from susceptibility to damage due to accidents or vibration or rough treatment. An ordinary pressure gauge is not protected from this damage, and on engines which have been in use for some time, may usually be found to be broken or damaged, or so lacking in accuracy as to be useless.

Thus, an entire lubrication system is provided which is simple, trouble-free and wherein means are provided to safeguard against normal mistakes and rough treatment caused by operating personnel. In this connection, it is pointed out that the connection of the camshaft 105 directly to the oil pump 175 substantially eliminates the possibility of an oil system failure independent of a general engine failure. So long as the camshaft operates, the oil pump will be driven, and should the camshaft fail, the engine would stop. So damage due to oil system failures are minimized.

It has been the practice heretofore to provide

some means in hand-cranked engines for relieving the cylinder head pressure due to compression during cranking. These means usually consist of a mechanism for holding the exhaust valve open until sufficient flywheel speed is attained to carry the engine through one or two cycles. The objection to this method is that it fills the cylinder with air, which of course, must be flushed out by a burnable mixture after the valve is released and an effort made to start the engine.

I prefer to relieve compression by holding the intake valve open so that the cylinder is filled with a burnable mixture during the initial cranking period and more efficient starting is obtained.

To accomplish this desirable result, an opening 228 is provided in the flywheel side of the jacket 46 in the portion of the jacket through which the push rods operate, and is adapted to be closed by a cover plate 229. An opening 230 is formed in the inner end of the plate. A suitable handle 231 has an integral shank 232 projecting through the opening and carrying an eccentrically mounted pin 233 on its inner end. A collar 234 is pressed or otherwise secured upon the pin adjacent the inner face of the plate 229 so that outward movement of the handle and pin assembly is prevented. The pin is adapted to engage the inner end of a spool 236 secured to the intake valve push rod 96, and is formed with an annular groove 235, semi-circular in cross-section, intermediate its ends, said groove being of sufficient depth as to allow proper clearance for the push rod. The spool 236 is cylindrical and carries annular flanges 237 at either end.

When the handle 231 is in its downward position, as shown in Fig. 14, the pin 233, due to its eccentric mounting, is in a lowered position and not in contact with the spool 236. The groove 235 provides clearance sufficient for the reciprocating movement of the push rod 96 normal during engine operation. The spool is so positioned as to clear the pin during such movement. However, in starting the engine, counter-clockwise movement of the handle will cause the pin to move upwardly into engagement with the spool and outwardly so as to force the push rod outwardly thereby actuating the rocker arm 88 and opening the intake valve 77. To hold the handle in this position, it is allowed to swing a little past top dead center so as to rest against a pin 238 projecting outwardly from the plate 229. A slight toggle action is achieved in this manner, whereby return of the handle to its downward position is prevented until such movement is accompliahed manually. Of course, after sufficient cranking speed is attained, the handle is swung downwardly to allow normal starting of the engine.

The plate 229 carries an opening and a mounting 239 at its outer end for receiving a fuel pump 240 which may be of any desirable type, although a diaphragm pump is normally used on this type of engine. The pump may, of course, include a fuel filter 241. The actuating lever 242 of the pump projects through the opening in the plate 229 into the interior of the jacket 46 and is engaged by the outer flange 237 of the spool 236 secured to the intake valve push rod. Thus, reciprocation of the push rod imparts motion to the lever 242 to actuate the fuel pump during operation of the engine.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. An internal combustion engine including, a crankcase, a crankshaft mounted in the crankcase, a cylinder extending from the case having a piston therein connected with the crankshaft, said crankcase having an opening in one side wall, a plate secured over the opening, a hanger block secured and supported upon the portion of the plate exposed through the opening, and a camshaft rotatably carried by the block and rotatably connected with the crankshaft.

2. An internal combustion engine as set forth in claim 1, wherein the camshaft extends substantially vertically within the crankcase, and an oil pump connected directly to the lower end of the camshaft.

3. An internal combustion engine as set forth in claim 2, wherein the hanger block is provided with a longitudinal oil passage leading from the pump, and an excessive oil pressure relief valve carried by the hanger and commuunicating with the oil passage thereof, the relief valve having its discharge adjacent to and directed at the camshaft.

4. An internal combustion engine as set forth in claim 1, wherein the outer surface of the crankcase adjacent the opening is machined smooth, and the inner face of the plate is machined smooth to provide an accurate surface upon which the hanger block is secured and supported.

5. An internal combustion engine including, a crankcase, a crankshaft mounted in the crankcase, a cylinder extending from the case having a piston therein connected with the crankshaft, said crankcase having an opening in one side wall, a plate secured over the opening, a hanger block secured upon the portion of the plate exposed through the opening, spaced bearings carried by the hanger block, a camshaft rotatably mounted in the bearings, a driven gear on the camshaft, and a driving gear on the crankshaft meshing with the driven gear, the hanger block having a longitudinal oil passage and branch oil passages leading from the longitudinal passage to the bearings and the driven gear.

6. An internal combustion engine as set forth in claim 5, and an oil pressure relief valve in the branch passage leading to the driven gear.

7. An internal combustion engine including, a crankcase, a crankshaft mounted in the crankcase, a cylinder extending from the case having a piston therein connected with the crankshaft, a hanger block detachably connected to the wall of the crankcase, a camshaft rotatably carried by the hanger block, a driving connection between the crankshaft and the camshaft, valve lifters carried by the hanger block, the block having a longitudinal oil passage and branch oil passages leading from the longitudinal passage to the driving connection, the valve lifters, and the camshaft for lubricating the same.

8. An internal combustion engine as set forth in claim 7, and an oil pressure relief valve in the branch oil line leading to the driving connection.

9. An internal combustion engine as set forth in claim 8, and an oil pump connected directly to one end of the camshaft with its outlet communicating with the longitudinal oil passage of the hanger block.

10. An internal combustion engine including, a crankcase, a crankshaft mounted in the crank-

case, a cylinder extending from the case having a piston therein connected with the crankshaft, a hanger block detachably connected to the wall of the crankcase, bearings carried by the hanger block, a camshaft rotatably carried by the hanger block bearings, a driving connection between the crankshaft and the camshaft, valve lifters carried in the hanger block, the block having a longitudinal oil passage extending therethrough and branch oil passages leading from the latter to the bearings, means for conducting lubricant from the longitudinal passage to the valve lifters, an oil pump connected to one end of the camshaft with its outlet communicating with the longitudinal oil passage of the hanger block, and an oil pressure relief valve carried by the block in communication with the longitudinal passage and having its discharge adjacent to and directed at the driving connection.

11. An internal combustion engine including, a crankcase, a crankshaft mounted in the crankcase, a cylinder block with a cylinder therein extending from the case, a piston in the cylinder connected with the crankshaft, a cylinder head having a coolant jacket removably secured to the cylinder block, a first oil passage formed integrally with the cylinder head extending through the coolant jacket in heat exchange relationship, a second oil passage formed integrally with the cylinder block and in communication with the first passage for conducting oil thereto, an oil pump in the crankcase, and oil conducting means leading from the oil pump to the second oil passage.

12. An internal combustion engine including, a crankcase, a crankshaft mounted in the crankcase, a cylinder block with a cylinder therein extending from the case, a piston in the cylinder connected with the crankshaft, a cylinder head removably secured to the cylinder block and having a portion abutting said cylinder block, a rocker arm support removably secured to the cylinder head and having a portion abutting said cylinder head, a first oil passage formed integrally with the support and extending from the portion thereof abutting to the cylinder head, a second oil passage formed integrally with the cylinder head and extending from the portion thereof abutted by the rocker arm support to the portion thereof abutting the cylinder block said second oil passage being in communication with the first passage for conducting oil thereto, a third oil passage formed integrally with the cylinder block and extending to the portion thereof abutted by the cylinder head, said third oil passage being in communication with the second passage for conducting oil thereto, an oil pump in the crankcase, and oil conducting means leading from the oil pump to the third oil passage.

13. A horizontal internal combustion engine including, a crankcase, a crankshaft mounted horizontally across the crankcase, a cylinder extending horizontally from the case having a piston therein connected with the crankshaft, a cylinder head removably secured upon the cylinder, valves in the cylinder head, a rocker arm support removably secured upon the cylinder head, rocker arms carried by the support and engaging the valves, push rods engaging the rocker arms and extending parallel to the cylinder, a hanger block in the crankcase, a vertical camshaft rotatably carried by the hanger block having valve lifter cams thereon, valve lifters carried by the hanger block and engaging the cams and the push rods, an oil pump connected directly to the lower end of the camshaft, a governor geared to the upper end of the camshaft, a magneto geared to the upper end of the camshaft, a driving gear on the crankshaft, and a driven gear on the camshaft meshing with said driving gear.

JOHN C. SLONNEGER.

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CURRENT GENERATING DEVICE

Filed June 7, 1951 4 Sheets-Sheet 1

Fig. 1.

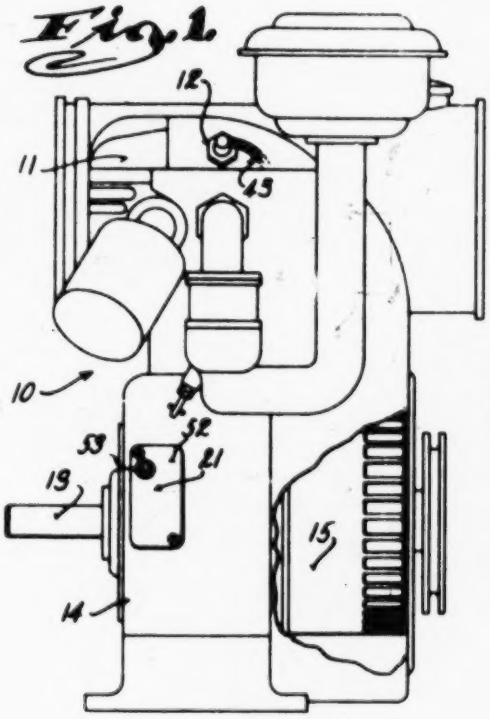


Fig. 2.

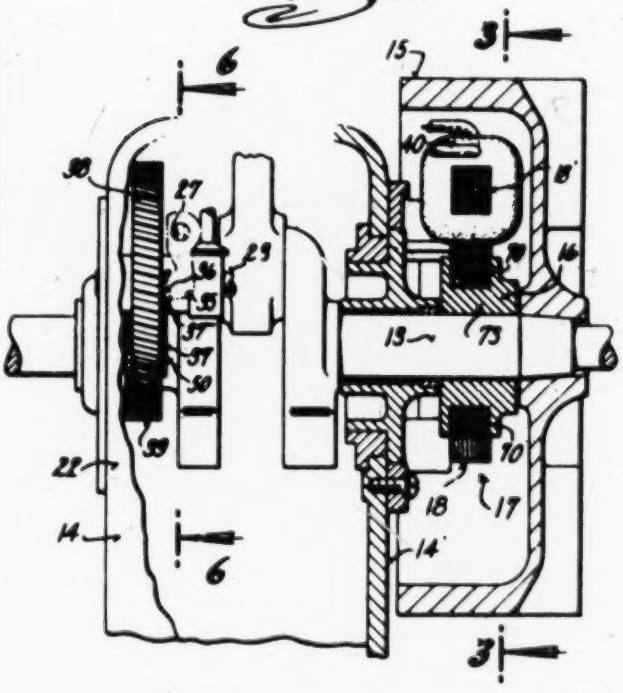
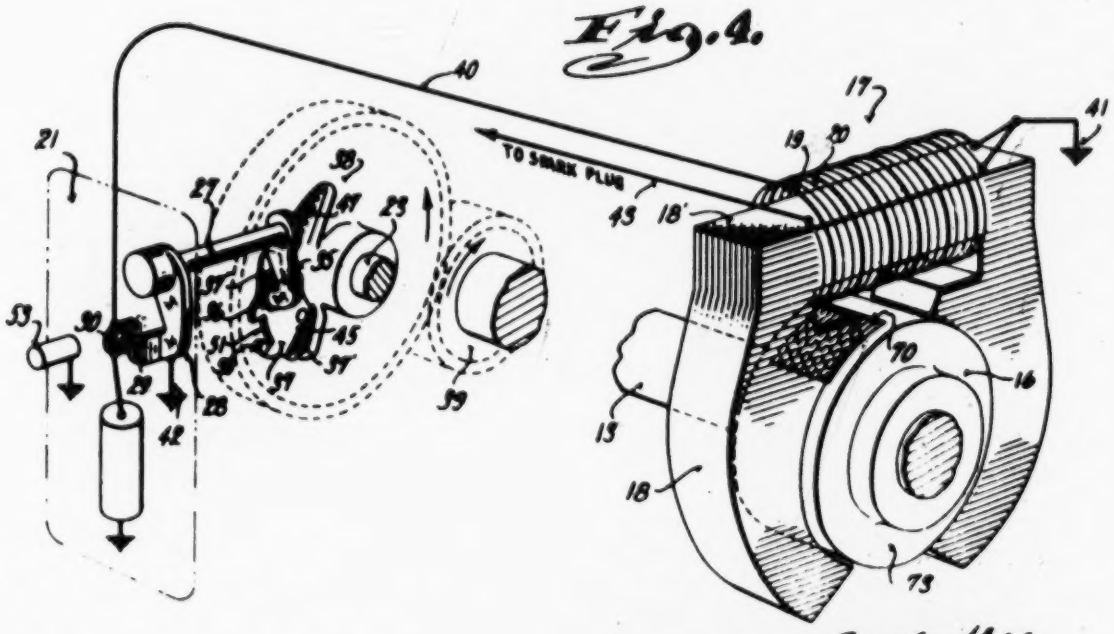


Fig. 4.



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CURRENT GENERATING DEVICE

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Fig. 3.

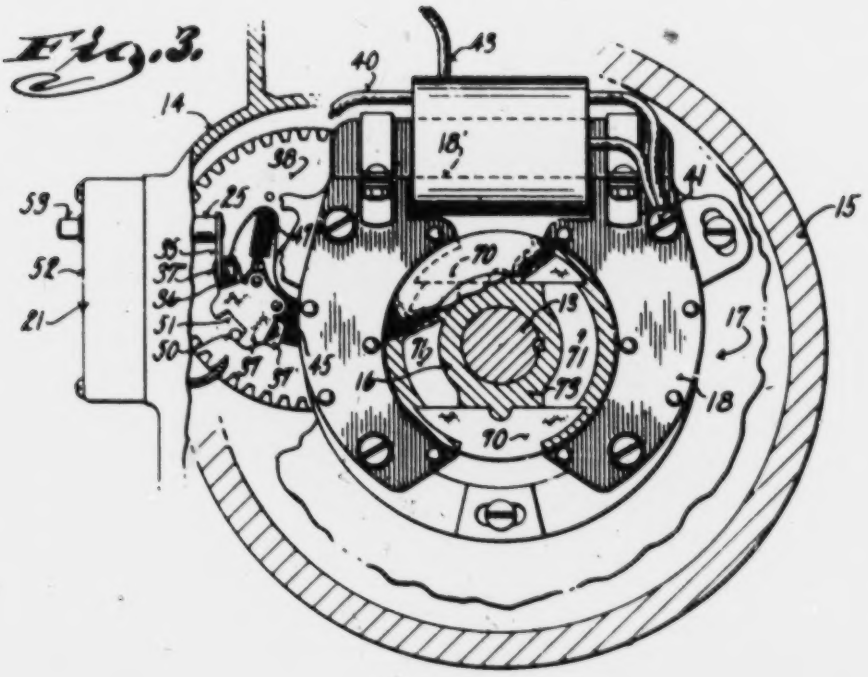


Fig. 5.

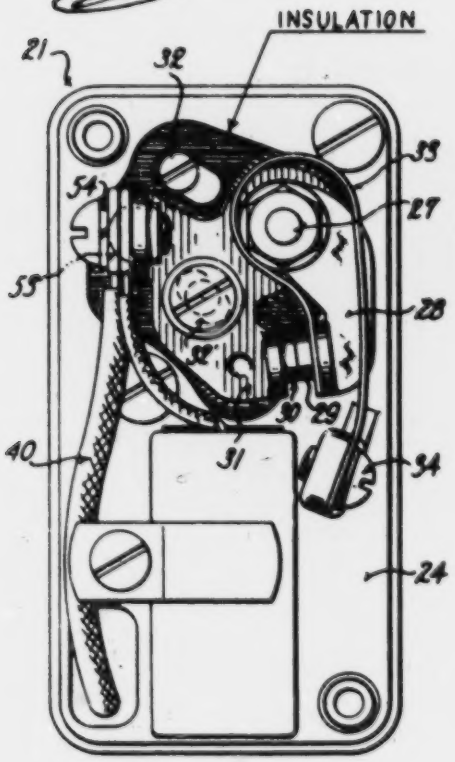
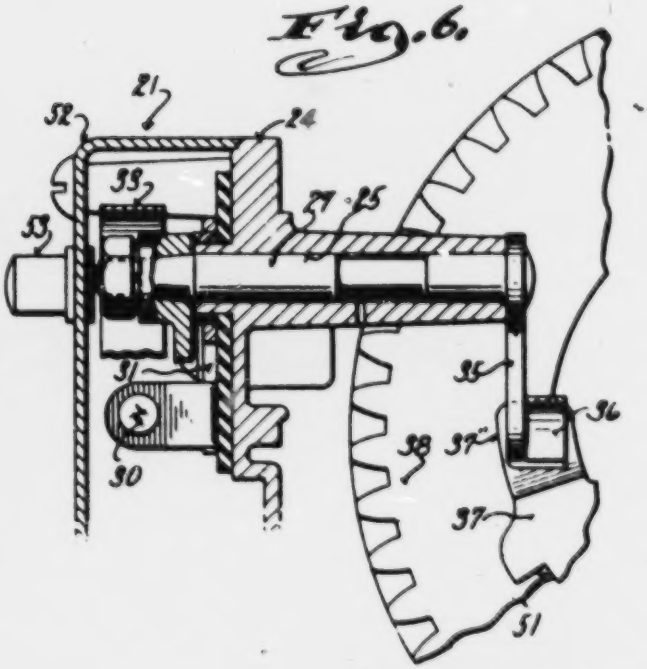


Fig. 6.



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CURRENT GENERATING DEVICE

Filed June 7, 1951 4 Sheets-Sheet 3

Fig. 1.

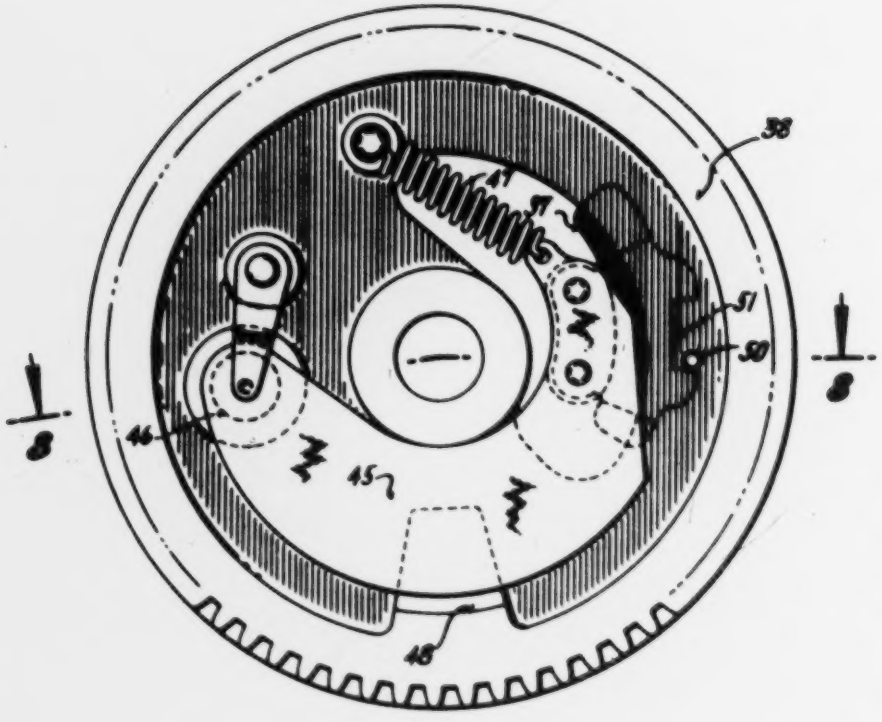

Fig. 8.

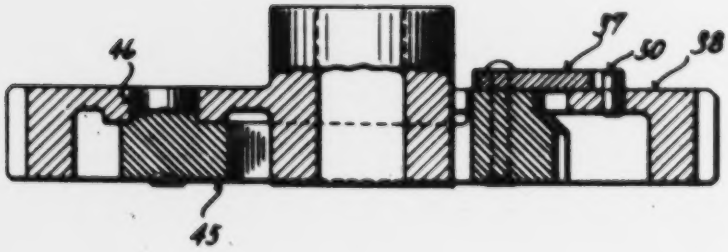

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Fig. 9.

CRANKING SPEED

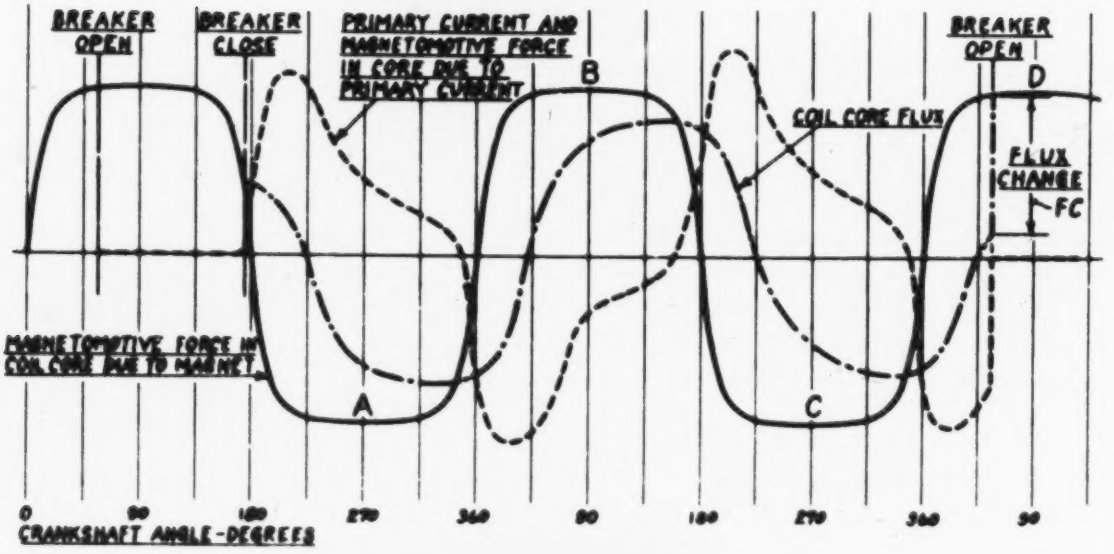
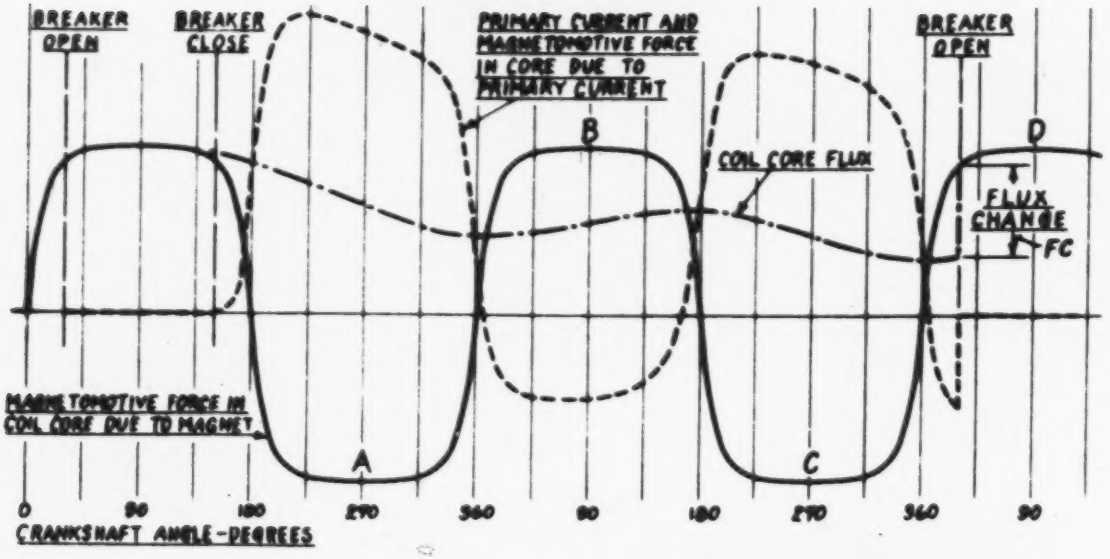


Fig. 10.

RUNNING SPEED



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2,605,753

UNITED STATES PATENT OFFICE

2,605,753

CURRENT GENERATING DEVICE

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Application June 7, 1951, Serial No. 230,296

19 Claims. (Cl. 123—149)

1

This invention has reference to current generating devices and is a continuation-in-part of the copending application of Alain M. Madle, deceased, Serial No. 108,293, filed August 3, 1949, which in turn was a continuation-in-part of application Serial No. 653,493, filed March 11, 1946, both of which applications are now abandoned.

More specifically this invention concerns the provision of an improved current generating system for internal combustion engines and especially single cylinder four stroke cycle engines of the so-called portable type.

The conventional crankshaft driven magneto while capable of performing its intended function of generating a suitable high E. M. F. for spark plug operation leaves much to be desired when used on small one cylinder high speed, high compression internal combustion engines.

Such magnetos usually have their magnets mounted on the flywheel to rotate with the engine crankshaft, and the crankshaft is provided with a cam for effecting separation of breaker contacts stationarily mounted on a wall of the engine covered by the flywheel.

Hence, the whole magneto assembly together with the breaker contacts for controlling firing of the spark plug is located alongside one wall of the engine and within the hollow interior of the flywheel. Access to any of the generator parts and especially the breaker contacts for adjustment or replacement thereof is thus either extremely difficult, or impossible, without considerable disassembly of the parts including the removal of the flywheel from the crankshaft.

Another disadvantage of the conventional crankshaft driven magneto when used with single cylinder engines wherein no distributor for the spark is required, resides in the fact that the breaker contacts are separated once each revolution of the crankshaft and thus effect firing of the spark plug twice during each four strokes of the engine, whereas only one spark is wanted for each four strokes, i. e., one spark for each two revolutions of the crankshaft.

The unwanted spark occurs at the top of the exhaust stroke of the piston and while it does not actually interfere with the operation of the engine, it shortens the life of the spark plug. Separation of the breaker contacts which produces this unwanted spark likewise results in unnecessary wear on the breaker contacts.

While the problem of the breaker produced unwanted spark may be solved by using a conventional cam shaft driven self-contained magneto, there are serious complications involved in

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the installation and driving of such a magneto on relatively small engines of the type here under consideration. Consequently the use of such cam shaft driven magnetos in small single cylinder engines is hardly practical. In any event the conventional cam shaft driven magneto is of doubtful value as a solution to the problem. Moreover, it is desirable that the magneto be driven by the engine crankshaft so as to obtain the advantage of the higher speed of rotation of the crankshaft for the production of suitably high firing voltages in the magneto.

Conventional two pole flywheel magnetos for high speed, high compression single cylinder engines having no distributor and wherein the breaker contacts are separated once each revolution of the crankshaft have another more serious disadvantage, namely the production of non-breaker produced sparks that occur while the breaker contacts are separated. These non-breaker produced sparks result from a change in coil core flux due solely to rotation of the rotor. In the most common type of bi-pole magneto wherein the poles on the rotor and stator are, respectively, diametrically opposite one another and symmetrical these unwanted non-breaker produced sparks that take place while the breaker contacts are separated tend to occur twice at equal time intervals each two revolutions of the engine crankshaft so that with the unwanted breaker produced spark which occurs near the top of the exhaust stroke the possibility exists of having three unwanted sparks during each cycle of the engine, once during each explosion and intake stroke and again near the top of each exhaust stroke; and above certain engine speeds all three of these unwanted sparks will occur.

While the cause of these unwanted sparks no doubt is understood by those skilled in the art, it may be helpful to point out that in each instance, i. e. breaker produced as well as non-breaker produced, the sparks result from rapid flux changes in the coil core. The curve of the magnetomotive force in the coil core due to the permanent magnet as a function of the movement of the rotor in a well designed magneto has an alternating substantially trapezoidal shape. The abrupt reversals in the curve, of course, correspond to the rapid flux changes in the coil core. The breaker produced sparks occur approximately at the end of every other reversal; and the non-breaker produced sparks occur just before the middle of the reversal since the maximum voltage occurs at the center of the reversal where the rate of change of the flux is

greatest. Thus, since the wanted spark, which of course is breaker produced, should occur about twenty degrees of engine rotation ahead of the piston top dead center at the end of the compression stroke, the position of the rotor with respect to engine rotation is such that the unwanted other breaker produced spark occurs just before the piston reaches the top of the exhaust stroke and the two unwanted non-breaker produced sparks occur during the latter half of the explosion and intake strokes.

The occurrence of unwanted sparks while the breaker contacts are separated depends upon the comparative values of the spark gap breakdown voltage and the voltage induced in the secondary winding. This breakdown voltage is relatively low during the intake and exhaust strokes because of the low pressure existing in the combustion chamber at these times and can, therefore, be easily exceeded by the induced voltage in the coil.

While these non-breaker produced sparks have a lower peak voltage than breaker produced sparks they are nevertheless highly objectionable. The prolonged nature of the unwanted non-breaker produced sparks in high speed engines coupled with the fact that breaker operation each revolution of the engine produces two more sparks each cycle of the engine causes excessive firing of the spark plug and overheating and corrosion of its electrodes; and the overheating results in preignition of the combustible mixture charged into the engine cylinder and loss of power developed by the engine.

As far as is known, little has been done to eliminate the unwanted spark resulting from breaker contact operation at the top of the exhaust stroke in engines equipped with crankshaft driven magnetos, but attempts have been made to minimize the undesirable effects of non-breaker produced sparks. The use of special "cold" plugs, and masking of the plug electrodes are two of the expedients resorted to in the past to offset these maverick sparks.

Masking is usually accomplished by a special cylinder head construction wherein the spark plug electrodes are located in the bottom of a well or recess having more or less limited communication with the cylinder. Thus, the weak but prolonged non-breaker produced maverick sparks across the electrodes can be prevented from causing preignition by the fact that the electrodes are masked by burnt gases from previous cycles. Special "cold" plugs are employed chiefly because of their ability to better withstand heat, and do not necessarily eliminate preignition.

But the control of non-breaker produced sparks by masking entails a special cylinder head construction and removes the spark plug electrodes from their most effective position within the cylinder. Moreover, it does not eliminate overheating of the spark plug electrodes which condition manifests itself in shorter spark plug life.

The main objection to these expedients which have been employed in the past to control maverick sparks, however, is that they deal not with the cause but the effect of the disturbing condition.

With the foregoing objections in mind, it is one of the main objects of this invention to provide a crankshaft operated magneto for single cylinder four cycle internal combustion engines having breaker contacts controlled by an engine

shaft rotating at one-half crankshaft speed so as to eliminate the unwanted breaker produced spark which would occur at the top of the exhaust stroke of the engine if the breaker operated at crankshaft speed.

Thus it will be noted that while the magneto rotor is driven at a speed suitably high for efficient operation, breaker contact separation takes place only once for each two revolutions of the engine crankshaft, i. e. once each engine cycle, at the proper time required to ignite the compressed mixture in the engine cylinder.

Another object of this invention resides in the provision of a magneto for single cylinder high speed, high compression engines wherein unwanted non-breaker produced or maverick sparks are eliminated.

In this respect it is another object of this invention to provide a magneto for single cylinder high speed, high compression internal combustion engines wherein objectionable maverick sparks are eliminated by the particular manner in which circuit breaker operation is effected. Thus by eliminating the cause there is no need for special structural provisions in the combustion chamber to prevent preignition.

A further object of this invention resides in the provision of a magneto for high speed, high compression engines wherein unwanted non-breaker produced or maverick sparks are eliminated, and wherein novel automatic spark advancing and retarding mechanism is employed.

Another object of this invention resides in the provision of a magneto for single cylinder internal combustion engines wherein the breaker contacts are located substantially remote from the flywheel and on the exterior of the engine crankcase so as to be readily accessible for adjustment or replacement.

With the above and other objects in view which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described, and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed in accordance with the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a side elevational view of an internal combustion engine equipped with the current generating system of this invention;

Figure 2 is an enlarged detail view partially in section of a portion of the engine shown in Figure 1;

Figure 3 is a cross sectional view taken on the plane of the line 3—3 of Figure 2, with the rotor of the magneto in a position at which its poles bridge the gaps between the poles of the stator and with the breaker cam in spark retarded position and having just allowed the breaker contacts to close,

Figure 4 is a diagrammatic view illustrating the essential elements of the magneto and the manner in which the breaker contacts control firing of the spark plug, the rotor of the magneto in this view being shown in a position partially bridging the gap between the stator poles, and the breaker cam in spark retarded position and shortly about to allow closure of the breaker contacts;

Figure 5 is a front view of the breaker box with its cover removed;

Figure 6 is a fragmentary sectional view taken on the plane of the line 6—6 of Figure 2;

Figure 7 is a view of the cam shaft gear illustrating the automatic spark advancing means;

Figure 8 is a cross sectional view taken on the plane of the line 8—8 of Figure 7;

Figure 9 is a diagram illustrating the magnetomotive force in the coil core due to the rotor magnets and the flux in the coil core and the current in the primary coil throughout a complete engine cycle at cranking speed at which time the spark is retarded; and

Figure 10 is a diagram similar to Figure 9 but showing the magnetomotive force in the coil core due to the rotor magnets and the flux in the coil core and the current in the primary coil at normal running speeds.

Referring now more particularly to the accompanying drawings in which like numerals indicate like parts throughout the several views, the numeral 10 generally designates a single cylinder four stroke cycle internal combustion engine of the small portable type, adapted to be operated at high speeds and having a relatively high compression ratio.

The engine is provided with the customary cylinder 11 and spark plug 12, while the crankshaft 13 projects from one side of the crankcase 14 to mount a flywheel 15 thereon in a more or less conventional manner. The flywheel 15 is of hollow construction, as illustrated, and has its open side facing the adjacent end wall 14' of the crankcase.

Mounted on the crankshaft between the hub of the flywheel and the adjacent end wall 14' of the crankcase is the rotor 16 of a magneto generally designated 17. The rotor 16 is of special construction and forms the subject matter of a companion application, Serial No. 230,295, filed June 7, 1951.

It has two diametrically opposite poles 70 connected by a pair of permanent magnets 71, the poles and magnets being embedded in a non-magnetic hub-like body 73. This body is bored to fit the crankshaft 13 to which it is secured to dispose the rotor within a stator 18 stationarily supported from the wall 14' of the crankcase inside the hollow interior of the flywheel. The stator 18 also has two diametrically opposite poles connected by a coil core 18' upon which the usual primary and secondary windings 19 and 20 respectively are mounted.

To the extent that the rotor of the magneto is driven by the crankshaft and the magneto parts per se are located within the hollow interior of the flywheel, the magneto of this invention follows conventional practice.

As stated previously, it was the custom in the past to support the breaker contacts for controlling spark plug operation on the end wall of the crankcase inside the flywheel, and to actuate the breaker contacts by means of a cam carried by the crankshaft of the engine. This arrangement, however, is objectionable for single cylinder four cycle engines having no distributor because the breaker contacts are then all but inaccessible, and because with that arrangement the breaker contacts were actuated every revolution of the crankshaft and thus produced an unwanted spark at the time the piston reached the top of its exhaust stroke. Such an unwanted spark does not interfere with operation of the engine, but it nevertheless shortens the life of the engine spark plug and causes excessive wear on the breaker contacts.

One of the objects of this invention is achieved by relocating the breaker contact assembly 21 remote from the flywheel and on the exterior of the side wall 22 of the crankcase which is adjacent to the cam shaft 23, where it is readily accessible for adjustment or replacement of the breaker contacts.

As best shown in Figures 5 and 6, the breaker contact assembly 21 is carried by a base plate 24 overlying an aperture (not shown) in the side wall 22 of the engine crankcase. A bearing 25 projecting from the back of the base plate extends into the interior of the crankcase toward the cam shaft 23 and has a stub shaft 27 journalled for oscillatory motion therein.

One end of the stub shaft 27 projects from the front of the base plate 24 to have the movable breaker arm 28 fixed thereon. The outer end of the breaker arm 28 has the movable contact 29 mounted thereon for cooperation with a stationary breaker contact 30.

The stationary contact 30 is carried by an adjustable plate 31 supported from the base plate 24 in a manner such that rotation of an eccentric 32 operates to adjust the position of the stationary contact with respect to the movable contact 29, a clamping screw 32' being provided to secure the plate 31 in adjusted position. A leaf spring 33 having one end anchored to the base plate as at 34 and its opposite end reacting against the movable breaker arm 28 acts to bias the breaker contacts into engagement with one another.

Fixed on the inner end of the stub shaft 27 which projects into the interior of the crankcase is an arm 35 having a cam follower 36 on its outer extremity arranged to be traversed by a breaker cam 37 carried by the cam shaft gear 38. As will be clear from Figure 2, the cam shaft gear is located on the cam shaft 23 near the wall of the crankcase remote from the flywheel and meshes with a pinion 39 on the crankshaft. Since the pinion has one-half the number of teeth of the cam shaft gear, the customary one-to-two ratio obtains between the crankshaft and cam shaft.

Inasmuch as the cam shaft rotates at one-half crankshaft speed, it will be apparent that the cam 37 acting through the arm 35 effects separation of the breaker contacts once each revolution of the cam shaft or once for each two revolutions of the crankshaft. This is highly advantageous in that it eliminates the unwanted spark which occurs in conventional one cylinder engine ignition systems at the top of the exhaust stroke, and thereby achieves another of the objects of this invention.

Referring to the diagram of Figure 4, it will be seen that one end of the primary winding 19 is electrically connected with the stationary contact 30 of the breaker assembly by means of a conductor 40. The opposite end of the primary winding, along with the adjacent end of the secondary winding, is grounded as at 41.

The movable contact 29 of the breaker assembly is also grounded as at 42 so that when the breaker contacts are engaged both ends of the primary winding are grounded and current may flow therein; and since the secondary winding is connected with the spark plug through a conductor 43 separation of the circuit breaker contacts by the cam 37 effects firing of the spark plug.

Attention is directed to the fact that the cam

37 has a relatively short angular length or dwell so as to only momentarily hold the breaker contacts separated. The separation of the contacts, which, as is well known, should be rapid, occurs when the steeply inclined leading end 37' of the cam rides under the cam follower; and upon such separation of the breaker contacts the spark plug fires. The timing of the breaker separation with respect to the engine cycle is, of course, determined by the position of the cam on the cam shaft gear 38; and this position, as will be hereinafter brought out, is automatically adjustable to advance the spark as the engine comes up to speed.

Because of the short angular length of the cam the breaker contacts are allowed to be reclosed by the spring 33 very soon after the plug has fired; but since the closure of the breaker contacts need not be as rapid as the opening and moreover cannot be faster than the action of the breaker spring, the trailing end 37'' of the cam is not as steep as its leading end.

The breaker contacts remain closed for most of the 360 degrees of rotation of the cam shaft 23 to normally maintain the primary winding connected to ground at both ends and in condition to have current flow therein. In other words, the primary winding is part of a closed circuit at all times except during the short interval the breaker contacts are opened to effect firing of the spark plug.

By keeping the breaker contacts normally closed in this manner and having the open period of the contacts take place when there is substantially no change in magnetomotive force in the coil core due to the permanent magnet, non-breaker produced or so-called maverick sparks are prevented. Since there is a substantial difference in the length of the arcuate pole faces of the rotor and stator there is a relatively long interval which occurs four times each engine cycle during which the rotor and stator pole faces overlap or oppose each other and the magneto motive force in the coil core due to the permanent magnet is substantially uniform and, of course, as the rotor pole faces sweep across the gaps between the stator poles this magneto motive force in the coil core due to the permanent magnet reverses abruptly.

As long as the breaker contacts are closed so that current may flow in the primary winding the abrupt changes in magnetomotive force in the coil core due to the permanent magnet during these reversals are incapable of causing maverick sparks because the current flowing in the closed primary circuit produces a magnetomotive force in the coil core in opposition to the magnetomotive force due to the permanent magnet. This bucking current prevents rapid flux changes and consequently precludes the generation of a maverick spark producing E. M. F. directly in the secondary winding.

In Figure 4, which depicts conditions during cranking, the rotor is shown in a position at which its pole faces partially bridge the gaps between the stator poles; and the cam 37 is about to allow the breaker contacts to close. At running speeds, when the cam 37 actuates the breaker contacts sooner in the engine cycle, the reclosure of the contacts takes place at approximately the instant the rotor pole faces begin to move into positions bridging the gaps between the stator poles. But at all speeds the opening of the breaker contacts takes place after the reversal of magnetomotive force in the coil core due to the permanent magnet directly preceding spark time and closes before the next successive reversal.

Reference to Figures 9 and 10 will facilitate an understanding of the manner in which this magneto operates, and since the maverick spark condition to be eliminated exists only at running speeds, attention is particularly directed to Figure 10.

The wave pattern of the magnetomotive force in the coil core due to the permanent magnet, represented by the heavy solid line in Figures 9 and 10 has the relatively flat plateaus shown to depict substantially uniform magnetomotive force because of the difference in the lengths of the rotor and stator pole faces. As already noted, by virtue of this difference the face of each rotor pole is opposite a stator pole face for a substantial angle of rotor rotation, and during this angular interval substantially no change takes place in magnetomotive force in the coil core due to the permanent magnet. Bearing in mind that for maverick sparks to occur requires the concurrence of a change in magnetomotive force in the coil core due to the permanent magnet and an open condition of the primary circuit, it follows that if the breaker contacts are closed during all changes in magnetomotive force in the coil core due to the rotor magnet that maverick sparks will be prevented.

Hence, the breaker cam 37, after opening the breaker contacts to produce the desired spark (at a time when there is no rotor magnet produced change in magnetomotive force) must allow the contacts to reclose before the next change in magnetomotive force due to the rotor magnet. Accordingly the cam 37 must be short enough to assure opening and reclosing of the breaker contacts during the angular interval that the rotor and stator pole faces are substantially opposite one another, but since the breaker mechanism must have time to function it follows that it is essential to have a relatively large difference in the arcuate length of the stator and rotor pole faces.

The sparking voltage is, of course, obtained from the secondary coil in which it is induced by the rapid change in flux in the coil core which occurs when the primary circuit is opened by separation of the breaker contacts. Since the breaker contacts close and open at times when the magnetomotive force due to the magnet is in the same direction no change of flux would occur when the breaker opened if the primary coil and its circuit had zero resistance. Under such a theoretical condition the coil core flux would remain at a constant value for a complete engine cycle which encompasses the four half cycles of of rotor rotation designated A, B, C and D.

However, since the primary circuit has resistance a decaying current, represented by the dotted line in the diagrams, obtains in the primary circuit. Because of this decaying current the coil core flux represented by the dot and dash lines on the diagram also decays, the overall decrease in coil core flux being represented by the dimension FC.

During the half cycle D and directly after the fourth complete reversal of magnetomotive force following closure of the breaker contacts the breaker contacts open and the flux changes abruptly by an amount equal to its net decay.

Since the net flux decay is a function of time, at higher engine speeds the time for decay is less and hence the net flux decay decreases with

increasing engine speeds. This decrease in flux decay results in a decrease in the amount of flux change at the instant of breaker contact opening so that the sparking voltage decreases with increasing engine speed.

Conversely at lower engine speeds the net flux decay is greater as will appear from a comparison of the value FC in the two diagrams Figures 9 and 10. Therefore, at cranking speeds the sparking voltage (which is approximately proportional to the value FC) is greater than at running speeds. This in an important advantage since it enables the attainment of the most desirable speed-voltage characteristic or curve.

Those skilled in the design of magnetos know that the sparking voltage, i. e. the voltage needed to fire the spark plug does not rise with increasing engine speed, but on the contrary drops. With all magnetos heretofore used on single cylinder engines the voltage at the spark plug continues to rise as the engine speed increases so that at normal running speeds it is far in excess of the voltage needed for proper firing. In fact, it is so high that the life of the plugs is far too short for satisfactory service. By contrast the speed-voltage curve of the magneto of this invention rises abruptly during starting speeds to reach maximum long before normal running speeds and then drops so that at running speeds the sparking voltage is actually lower than at starting but still comfortably above minimum requirements. Obviously this reduces the electrical strain upon the spark plug points.

The explanation for this advantage lies in the fact that the breaker points are operated at one-half crankshaft speed and remain uninterruptedly closed for most of the cycle.

In considering the diagrams, Figures 9 and 10, it should be borne in mind that the low speed diagram (Figure 9) is greatly condensed along its time axis so that although there appear to be rapid and abrupt flux changes, actually these changes which are due to the decay of the current are gradual. The important consideration is that no rapid flux changes can occur as long as the breaker contacts are closed and since the magneto is so designed that the breaker contacts are open only when there is no tendency for rotor rotation to rapidly change the flux (which could only occur at running speeds) it follows that all unwanted firing of the spark plug is eliminated.

This invention, therefore, not only eliminates the unwanted spark which is normally produced in one cylinder engines having crankshaft operated breaker contacts, but also eliminates the non-breaker produced sparks which seriously interfered with engine operation in the past; and also provides accessibility to the breaker contacts.

The automatic retarding of the spark referred to hereinbefore is achieved by mounting the breaker cam 37 on the free end of a centrifugally actuated weight 45 having an eccentric pivotal connection 46 with the cam shaft gear. This weight, as best shown in Figures 7 and 8 is carried by the cam shaft gear at the side thereof opposite the breaker cam. A coil spring 47 having one end anchored to the cam shaft gear 38 is attached to the free end of the weight to hold the same in its inner position holding the breaker cam 37 in a "retarded spark" position. As the engine speed increases centrifugal force acting on the weight rotates the same about its pivot 46 toward the surface 48 on the cam shaft gear to angularly shift the breaker cam 37 in the direction of rotation of the cam shaft and thereby advance the spark timing.

Spark advancing and retarding actually is limited, however, by engagement of a pin 50 on the gear 38 with the opposite ends of a notch 51 cut into the side of the breaker cam 37. In the starting position shown in Figures 7 and 8 the spring 47 is shown holding the cam "retarded" with one end of the notch of the breaker cam engaged with the pin 50.

For the sake of appearance and to afford a degree of protection for the breaker contacts the base plate 24 is preferably provided with a detachable cover 52 to close the breaker assembly. This cover carries a stop button 53 at its exterior which when depressed into the cover engages the terminal 54 of the breaker assembly to ground the magneto primary despite the condition of the breaker contacts and to thereby effect stopping of the engine.

From the foregoing description taken in connection with the accompanying drawings, it will be readily apparent to those skilled in the art that this invention provides a highly improved magneto and breaker control therefor which is advantageous from the standpoint that it enables the elimination of all unwanted sparks; that it achieves the ideal speed-voltage characteristic of high voltage at cranking speeds and lower voltage at running speeds; and that it enables the breaker contacts to be placed in a readily accessible location remote from the flywheel.

What is claimed as the invention is:

1. In an ignition system for a single cylinder four cycle internal combustion engine of the type having a crankshaft driven magneto, a crankcase, and a cam shaft geared to said crankshaft to rotate at one-half crankshaft speed; fixed and movable breaker points mounted on the exterior of the crankcase in a position substantially remote from the magneto but readily accessible from the exterior of the engine; a cam follower in juxtaposition to a face of the cam shaft gear; a motion transmitting connection between said cam follower and the movable breaker point; and means for effecting momentary separation of said breaker contacts once each two revolutions of the crankshaft, said means including an arm having one of its ends pivoted to a face of the cam shaft gear eccentrically thereof so as to be bodily movable with the gear, and so that the opposite end of the arm is free for arcuate motion in the plane of the gear face and to advance relative to the periphery of the gear in the direction of rotation of the gear as a result of centrifugal force consequent to rotation of the gear; means yieldingly biasing said arm against such advancing motion; and a cam surface carried by said arm and adapted to cooperate with said cam follower to momentarily separate the breaker points only once during each revolution of the cam shaft.

2. In an ignition system for a single cylinder four cycle internal combustion engine of the type having a crankshaft driven magneto and a cam shaft geared to the crankshaft for rotation therewith at one-half crankshaft speed: a pair of normally engaged breaker contacts; and means for effecting momentary separation of said breaker contacts once each revolution of the cam shaft, said means comprising a part fixed on the cam shaft to rotate therewith, and a cam mounted on said part for motion relative thereto in consequence to centrifugal force, said cam being movable in a direction to effect earlier separation

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of the breaker contacts as the engine approaches normal operating speeds.

3. In an ignition system for a single cylinder four cycle internal combustion engine of the type having a crankshaft driven magneto and a cam shaft geared to the crankshaft for rotation therewith at one-half crankshaft speed: normally closed fixed and movable breaker points; a cam follower connected with the movable breaker point and operable to effect separation thereof from the fixed point; a part fixed on the engine cam shaft to rotate therewith; a cam; and means mounting the cam on said part for momentary engagement with and operation of said cam follower once during each revolution of the cam shaft so as to effect momentary separation of the breaker points during such operation of the cam follower, said means providing for motion of the cam relative to said part in a direction to effect earlier separation of said breaker points in response to increased centrifugal force on said part due to an increase in the rate of rotation of the cam shaft.

4. In an ignition system for a single cylinder four cycle internal combustion engine having a crankshaft driven magneto and fixed and movable breaker points: a wheel rotatably driven from the engine crankshaft at a fixed speed with respect to the crankshaft; an arcuate arm having one of its ends pivotally connected to the wheel at one face thereof to swing about an axis spaced from the center of the wheel in response to centrifugal force during rotation of the wheel, said arm having its free end overlying a slot formed in the side of the wheel substantially diametrically opposite the pivot point of the arm; means for momentarily separating the breaker points once each revolution of said wheel, including a cam disposed at the opposite face of said wheel, and means projecting through said arcuate slot in the wheel to connect the cam with the free end of said arm for motion of the cam with the arm; and a spring reacting between the arm and the wheel to hold the arm with the cam in a position at one end of the slot corresponding to retarded opening of the breaker points, said spring being yieldable in response to centrifugal force on the arm to allow the free end of the arm to carry the cam to the other end of the slot during high speed operation of the engine to effect earlier separation of the breaker points.

5. In an ignition system for a single cylinder four cycle internal combustion engine of the type having a crankshaft driven magneto for effecting spark plug operation: fixed and movable breaker points accessibly mounted on the exterior of the engine remote from the magneto; a cam follower movably supported by the engine remote from the breaker points; a motion transmitting connection between the cam follower and the movable breaker point such that separation of the points is effected by motion of the cam follower in one direction; a rotatable part adjacent to said cam follower; a driving connection between said rotatable part and the engine crankshaft whereby the speed of rotation of the crankshaft determines the speed of rotation of said rotatable part; a member carried by said rotatable part for rotation therewith and for motion relative thereto in response to centrifugal force; and a cam surface on said member engaged by said cam follower for imparting motion to the cam follower in said direction once each revolution of the rotatable part to effect breaker point separation at instants depending upon the speed of crankshaft rotation and the position of said member relative to the rotatable part as determined by the centrifugal force acting on said member.

6. In an ignition system for a single cylinder four stroke cycle internal combustion engine of the type having a crankshaft driven magneto and a cam shaft driven from the crankshaft for rotation therewith at one-half crankshaft speed: a pair of normally engaged breaker contacts; means for effecting momentary separation of said breaker contacts once each revolution of the cam shaft, said means comprising a part fixed on the cam shaft to rotate therewith, a centrifugally responsive breaker cam mounted on said part to rotate therewith and for back and forth motion relative thereto, said cam being movable in one direction relative to said part to effect earlier separation of the breaker contacts in consequence to centrifugal force as the speed of the engine increases; means for limiting back and forth motion of the cam relative to said part so as to define the spark advanced and retarded positions of the cam; and biasing means acting on the cam to yieldingly resist motion thereof in said direction in response to centrifugal force.

7. In an ignition system for an internal combustion engine of the type having a crankshaft driven magneto for effecting spark plug operation, and fixed and movable breaker points actuated by a cam follower for timing the occurence of the spark with respect to the rotational position of the crankshaft, means for automatically varying the timing of breaker point operation in accordance with the rate of rotation of the crankshaft, comprising: a member rotatably driven in one direction from the crankshaft, said member having opposite faces normal to its axis of rotation; an arm overlying one face of said member and extending laterally thereacross to one side of the axis of the member, the ends of the arm being disposed substantially diametrically opposite one another; means pivotally connecting one end of the arm to said member so that the other end of the arm may swing back and forth across said face of the member, said other end of the arm being centrifugally responsive and being adapted to swing relative to said member in the direction in which the member rotates as the speed of the engine increases; a projection on said other end of the arm extending through a slot in said member; a cam on said projection adapted to operatively engage the cam follower once during each revolution of the member, said cam overlying the opposite face of the member so that the member is interposed between said cam and the arm to guide the arm in its swinging motion; and means yieldingly urging the arm to swing counter to the direction of rotation of said member so as to yieldingly resist response of the arm to centrifugal force.

8. In an ignition system for an internal combustion engine having a crankshaft and fixed and movable breaker points operated by a cam actuated follower, means for automatically varying the timing of breaker point operation in accordance with the speed of the engine, comprising: a member rotatably driven in one direction from the crankshaft of the engine, said member having opposite faces normal to its axis of rotation; an arm overlying one face of said member with its ends lying at substantially diametrically opposite sides of the axis of the mem-

ber and its body extending around to one side of the axis of the member; means pivotally connecting one end of said arm to the member and constraining the other end of the arm to swinging motion parallel to said face of the member, said other end of the arm being adapted to swing in one direction relative to the member in consequence to centrifugal force as the speed of rotation of the member increases; an axial thrust cam connected with said other end of the arm to be moved thereby, said cam having a cam surface thereon exposed at the opposite face of the member for engagement with the cam follower to move the same away from said opposite face of the member and effect actuation of the breaker points once each revolution of said member, said cam having a portion overlying and bearing against said opposite face of the member whereby reaction of the cam to the thrust of the cam follower is taken by that portion of the member which the cam overlies; biasing means yieldably restraining movement of the arm in response to centrifugal force; and stop means on said member for defining the limits of motion of the arm in response to centrifugal force and to said biasing means.

9. In an ignition system for an internal combustion engine having a crankshaft and fixed and movable breaker points operated by a cam actuated follower, means for automatically varying the timing of breaker point operation in accordance with the speed of the engine, comprising: a member rotatably driven from the engine crankshaft; a cam for actuating said follower; means connecting the cam with said member for bodily rotation therewith and for movement relative thereto in a plane substantially perpendicular to the axis of rotation of the member, movement of the cam in one direction relative to said member effecting earlier engagement of the cam with its follower, said connecting means including a weighted centrifugally responsive arm eccentrically pivoted on the member so as to effect movement of the cam relative to the member in said direction in response to centrifugal force acting on the arm as the speed of rotation of said member increases; a spring reacting between the cam and said member and tending to move the cam in the opposite direction so as to yieldingly resist response of said arm to centrifugal force; and a surface on said member along which the cam moves and against which it bears to transmit the thrust of the cam follower to said member.

10. In an ignition system for an internal combustion engine having a cam shaft and a timing gear thereon by which the cam shaft is driven from the crankshaft of the engine at one-half crankshaft speed: fixed and movable breaker contacts; a breaker cam; means mounting the cam on said timing gear for bodily rotation therewith and for motion relative thereto in the direction of rotation of the timing gear in response to centrifugal force; a spring reacting between the cam and the timing gear and tending to move the cam in the opposite direction; stop means on the timing gear for limiting motion of the cam relative to the timing gear under the influence of centrifugal force as well as of said springs; a cam follower alongside the timing gear in position to be operatively engaged by said cam once each revolution of the timing gear; and a motion transmitting connection between the cam follower and the movable breaker contact.

11. A high speed, high compression, single cylinder internal combustion engine having a spark plug and a crank shaft driven bipole magneto having stator and rotor elements, provided with inductively coupled primary and secondary windings on a coil core which connects the poles of one of the magneto elements and a permanent magnet connecting the poles of the other element to produce a magnetomotive force in the coil core which reverses twice for each revolution of the rotor element, wherein the primary circuit is normally closed and is open only when a pair of normally closed breaker contacts connected in the primary circuit are opened, and wherein the spark plug is fired by the high sparking voltage induced in the secondary winding each time the normally closed breaker contacts are opened: characterized by the fact that the longest pole face of one of the magneto elements is considerably shorter than the shortest pole face of the other magneto element and the pole faces of one magneto element are of such length and so related to the pole faces of the other magneto element that for an instant the gaps between the pole faces of each magneto element are simultaneously substantially bridged by the pole faces of the other, at which instant the magnetomotive force in the coil core due to the permanent magnet abruptly reverses, the interval of rotor rotation directly following such abrupt reversal producing a high substantially uniform magnetomotive force in the coil core due to the permanent magnet; and further characterized by the fact that the breaker contacts are controlled by a single lobed breaker cam driven at one-half crankshaft speed, the effective angular length of which is such that opening and reclosure of the breaker contacts can take place during said interval of rotor rotation when the magneto motive force in the coil core due to the permanent magnet is substantially uniform, and by the fact that the cam is so timed with respect to the rotor position at the desired spark time as to effect opening of the breaker contacts shortly after the reversal in magneto motive force directly preceding said interval of rotor rotation and reclosure of the breaker contacts before the next successive reversal in magnetomotive force so that whenever the primary circuit is open the magnetomotive force in the coil core due to the permanent magnet remains substantially unchanged, and whenever the magnetomotive force in the coil core due to the permanent magnet is changing the primary circuit is closed and current flows through the primary winding to produce a magnetomotive force in the coil in opposition to the magnetomotive force therein due to the permanent magnet to thereby prevent rapid flux changes in the coil core, which unless prevented, would result in unwanted non-breaker produced firing of the spark plug.

12. A high speed, high compression, single cylinder internal combustion engine having a spark plug and a crankshaft driven bipole magneto having stator and rotor elements, provided with inductively coupled primary and secondary windings on a coil core which connects the poles of one of the magneto elements and a permanent magnet connecting the poles of the other element to produce a magnetomotive force in the coil core which reverses twice for each revolution of the rotor element, wherein the primary circuit is normally closed and is open only when a pair of normally closed breaker contacts connected in the primary circuit are opened, and wherein the spark plug is fired by the high

sparking voltage induced in the secondary winding each time the normally closed breaker contacts are opened: characterized by the fact that the longest pole face of one of the magneto elements is considerably shorter than the shortest pole face of the other magneto element and the pole faces of one magneto element are of such length and so related to the pole faces of the other magneto element that for an instant the gaps between the pole faces of each magneto element are simultaneously substantially bridged by the pole faces of the other, at which instant the magneto motive force in the coil core due to the permanent magnet abruptly reverses, the interval of rotor rotation directly following such abrupt reversal producing a high substantially uniform magnetomotive force in the coil core due to the permanent magnet; and further characterized by the fact that the breaker contacts are controlled by an engine driven single lobed breaker cam, the effective angular length of which is such that opening and reclosure of the breaker contacts can take place during said interval of rotor rotation when the magnetomotive force in the coil core due to the permanent magnet is substantially uniform, and by the fact that the cam is so timed with respect to the rotor position at the desired spark time as to effect opening of the breaker contacts shortly after the reversal in magnetomotive force directly preceding said interval of rotor rotation and reclosure of the breaker contacts before the next successive reversal in magnetomotive force so that whenever the primary circuit is open the magnetomotive force in the coil core due to the permanent magnet remains substantially unchanged, and whenever the magnetomotive force in the coil core due to the permanent magnet is changing the primary circuit is closed and current flows through the primary winding to produce a magnetomotive force in the coil core in opposition to the magnetomotive force therein due to the permanent magnet to thereby prevent rapid flux changes in the coil core, which unless prevented, would result in unwanted non-breaker produced firing of the spark plug.

13. A high speed, high compression, single cylinder internal combustion engine having a spark plug and a crankshaft driven bipole magneto having stator and rotor elements, provided with inductively coupled primary and secondary windings on a coil core which connects the poles of one of the magneto elements and a permanent magnet connecting the poles of the other element to produce a magnetomotive force in the coil core which reverses twice for each revolution of the rotor element, wherein the primary circuit is normally closed and is open only when a pair of normally closed breaker contacts connected in the primary circuit are opened, and wherein the spark plug is fired by the high sparking voltage induced in the secondary winding each time the normally closed breaker contacts are opened: characterized by the fact that the faces of each magneto element are of equal length and the faces of one of the magneto elements are considerably longer than the faces of the other magneto element and the pole faces of one magneto element are of such length and so related to the pole faces of the other magneto element that for an instant twice each revolution of the rotatable magneto element the gaps between the poles faces of each magneto element are simultaneously substantially bridged by the pole faces of the other, at which instant the magnetomotive force in the coil core due to the permanent magnet abruptly reverses, the interval of rotor rotation directly following such abrupt reversal producing a high substantially uniform magnetomotive force in the coil core due to the permanent magnet; and further characterized by the fact that the breaker contacts are controlled by a single lobed breaker cam driven at one-half crankshaft speed, the effective angular length of which is such that opening and reclosure of the breaker contacts can take place during one of said intervals of rotor rotation when the magnetomotive force in the coil core due to the permanent magnet is substantially uniform, and by the fact that the cam is so timed with respect to the rotor position at the desired spark time as to effect opening of the breaker contacts shortly after the reversal in magnetomotive force directly preceding said interval of rotor rotation and effects reclosure of the breaker contacts before the next successive reversal in magnetomotive force, so that whenever the primary circuit is open the magnetomotive force in the coil core due to the permanent magnet remains substantially unchanged and whenever the magnetomotive force in the coil core due to the permanent magnet is changing the primary circuit is closed and current flows through the primary winding to produce a magnetomotive force in the coil core in opposition to the magnetomotive force therein due to the permanent magnet to thereby prevent rapid flux changes in the coil core, which unless prevented, would result in unwanted non-breaker produced firing of the spark plug.

14. A high speed, high compression, single cylinder internal combustion engine having a spark plug and a crankshaft driven bipole magneto having stator and rotor elements, provided with inductively coupled primary and secondary windings on a coil core which connects the poles of one of the magneto elements and a permanent magnet connecting the poles of the other element to produce a magnetomotive force in the coil core which reverses twice for each revolution of the rotor element, wherein the primary circuit is normally closed and is open only when a pair of normally closed breaker contacts connected in the primary circuit are opened and wherein the spark plug is fired by the high sparking voltage induced in the secondary winding each time the normally closed breaker contacts are opened: characterized by the fact that the faces of each magneto element are of equal length and the faces of one of the magneto elements are considerably longer than the faces of the other magneto element and the pole faces of one magneto element are of such length and so related to the pole faces of the other magneto element that for an instance twice each revolution of the rotatable magneto element the gaps between the pole faces of each magneto element are simultaneously substantially bridged by the pole faces of the other, at which instant the magnetomotive force in the coil core due to the permanent magnet abruptly reverses, the interval of rotor rotation directly following such abrupt reversal producing a high substantially uniform magnetomotive force in the coil core due to the permanent magnet; and further characterized by the fact that the breaker contacts are controlled by an engine driven single lobed breaker cam, the effective angular length of which is such that opening and reclosure of the breaker contacts can take place during one of said intervals of rotor rotation when the magnetomotive force in the coil core due to the

permanent magnet is substantially uniform, and by the fact that the cam is so timed with respect to the rotor position at the desired spark time as to effect opening of the breaker contacts shortly after the reversal in magnetomotive force directly preceding said interval of rotor rotation and effects reclosure of the breaker contacts before the next successive reversal in magnetomotive force, so that whenever the primary circuit is open the magnetomotive force in the coil core due to the permanent magnet remains substantially unchanged and whenever the magnetomotive force in the coil core due to the permanent magnet is changing the primary circuit is closed and current flows through the primary winding to produce a magnetomotive force in the coil core in opposition to the magnetomotive force therein due to the permanent magnet to thereby prevent rapid flux changes in the coil core, which unless prevented, would result in unwanted non-breaker produced firing of the spark plug.

15. A high speed, high compression, single cylinder internal combustion engine having a spark plug and a crankshaft driven symmetrical bipole magneto having a stator and a rotor, provided with inductively coupled primary and secondary windings on a coil core which connects the poles of the stator, wherein a permanent magnet connecting the poles of the rotor produces a magnetomotive force in the coil core which reverses twice for each revolution of the rotor, wherein the primary circuit is normally closed and is open only when a pair of normally closed breaker contacts connected in the primary circuit are opened, and wherein the spark plug is fired by the high sparking voltage induced in the secondary winding each time the normally closed breaker contacts are opened: characterized by the fact that the pole faces of the stator which are equal in length are considerably longer than the pole faces of the rotor which are also of equal length, the respective lengths of said pole faces being such that for an instant twice each revolution of the rotor the gaps between the pole faces of each magneto element are simultaneously substantially bridged by the pole faces of the other, at which instant the magnetomotive force in the coil core due to the permanent magnet abruptly reverses, the interval of rotor rotation directly following such abrupt reversal producing a high substantially uniform magnetomotive force in the coil core due to the permanent magnet; and further characterised by the fact that the breaker contacts are controlled by a single lobed breaker cam driven at one-half crankshaft speed, the effective angular length of which is such that opening and reclosure of the breaker contacts can take place during one of said intervals of rotor rotation when the magnetomotive force in the coil core due to the permanent magnet is substantially uniform, and by the fact that the cam is so timed with respect to the rotor position at the desired spark time as to effect opening of the breaker contacts shortly after the reversal in magnetomotive force directly preceding said interval of rotor rotation and reclosure of the breaker contacts before the next successive reversal in magnetomotive force so that whenever the primary circuit is open the magnetomotive force in the coil core due to the permanent magnet remains substantially unchanged and whenever the magnetomotive force in the coil core due to the permanent magnet is changing the primary circuit is closed and current flows through the primary winding to produce a magnetomotive force in the coil core in opposition to the magnetomotive force therein due to the permanent magnet to thereby prevent rapid flux changes in the coil core, which unless prevented, would result in unwanted non-breaker produced firing of the spark plug.

16. The combination set forth in claim 11 wherein the position of the breaker cam is adjustable with respect to the rotor element to advance or retard the spark; means biasing the breaker cam in a direction to retard the spark; centrifugally responsive means acting upon the breaker cam to advance the spark with increasing engine speed; and stop means limiting the adjustment of the breaker cam to a range which affords proper spark timing at all speeds and at running speeds effects opening and closing of the breaker contacts within said interval of rotor rotation during which a high substantially uniform magnetomotive force is produced in the coil core due to the permanent magnet.

17. The combination set forth in claim 16 further characterized by the fact that the open period of the breaker contacts at running speeds substantially coincides with said interval of rotor rotation during which a high substantially uniform magnetomotive force is produced in the coil core due to the permanent magnet.

18. The combination set forth in claim 15 wherein the position of the breaker cam is adjustable with respect to the rotor element to advance or retard the spark; means biasing the breaker cam in a direction to retard the spark; centrifugally responsive means acting upon the breaker cam to advance the spark with increasing engine speed; and stop means limiting the adjustment of the breaker cam to a range which affords proper spark timing at all speeds and at running speeds effects opening and closing of the breaker contacts within said interval of rotor rotation during which a high substantially uniform magnetomotive force is produced in the coil core due to the permanent magnet.

19. The combination set forth in claim 18 further characterized by the fact that the open period of the breaker contacts at running speeds substantially coincides with said interval of rotor rotation during which a high substantially uniform magnetomotive force is produced in the coil core due to the permanent magnet.

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Administratrix of the Estate of Alain M. Madlé, Deceased.

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INTERNAL-COMBUSTION ENGINE

Filed Oct. 6, 1948 2 SHEETS—SHEET 1

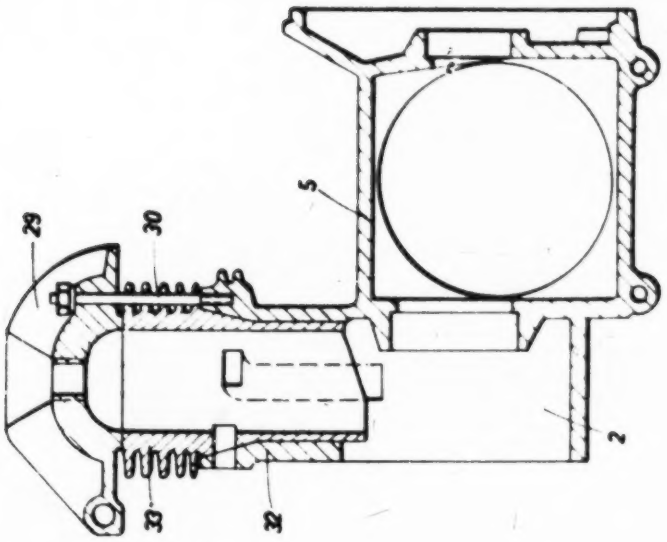

Fig 3

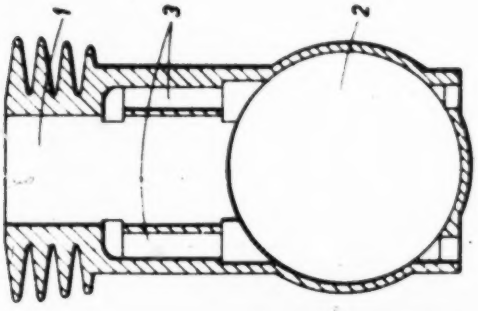

Fig 2

Fig. 4

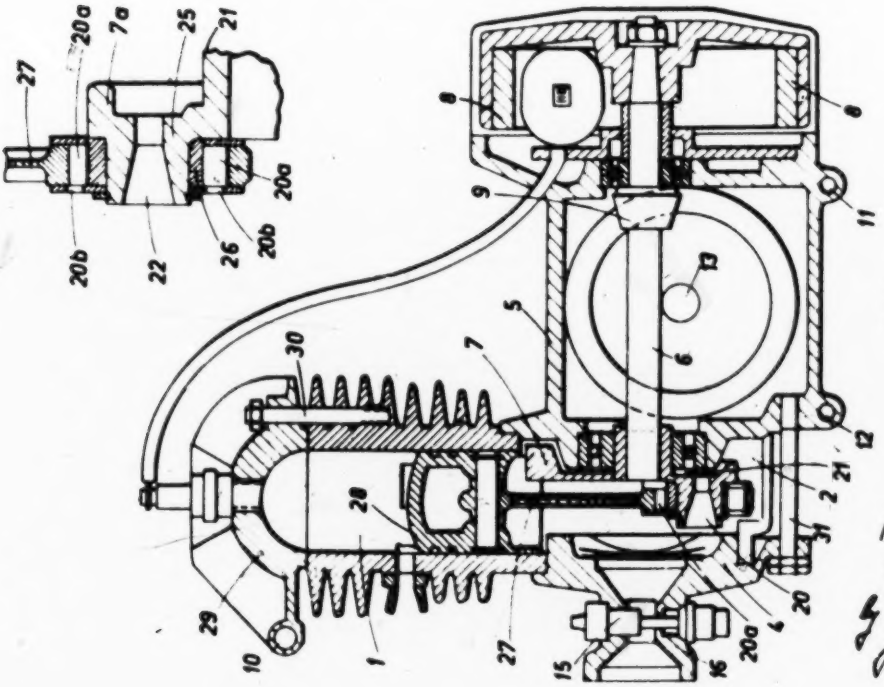

Fig. 1

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INTERNAL-COMBUSTION ENGINE

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Fig. 6

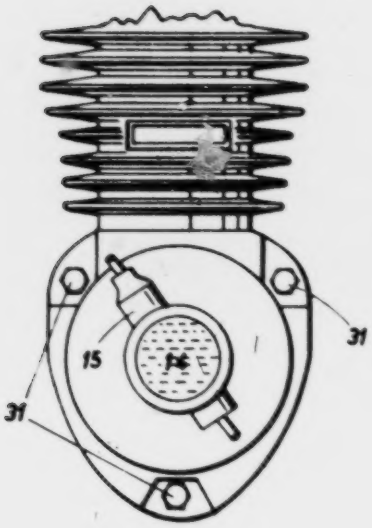
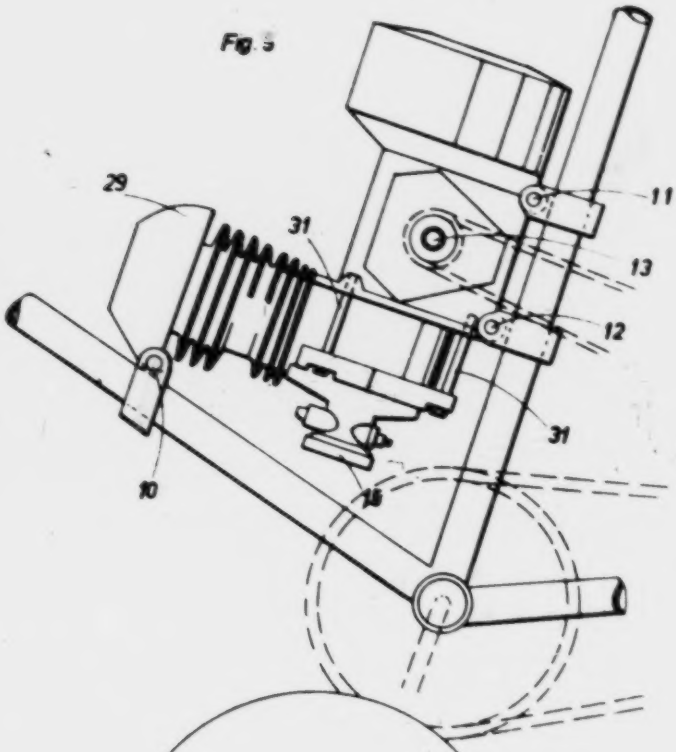


Fig. 5



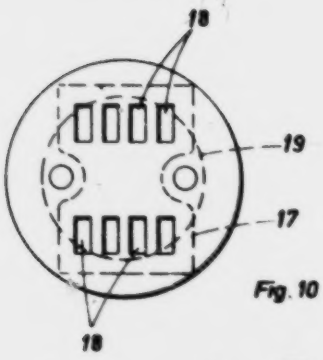


Fig. 10

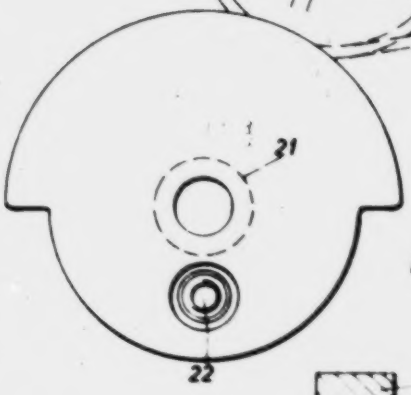


Fig. 7

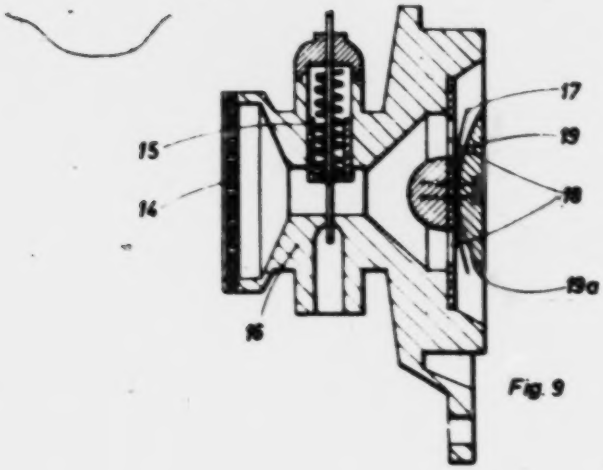


Fig. 9

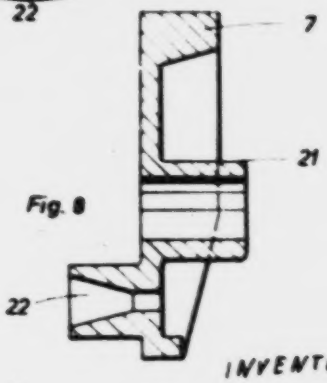


Fig. 8

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UNITED STATES PATENT OFFICE

2,606,541

INTERNAL-COMBUSTION ENGINE

Otto Lutz, Braunschweig, Germany

Application October 6, 1948, Serial No. 53,123
In Great Britain October 16, 1947

14 Claims. (Cl. 123—73)

1

My invention relates to small single cylinder internal combustion piston engines suitable for use, for example, as the auxiliary engines of pedal bicycles.

An object of my invention is to provide a sturdy cheap construction having a favourable power weight ratio and especially so in the case of small two-stroke single cylinder engines suitable for use as the auxiliary engine of a bicycle of ordinary construction.

To conduce to this end another object of the present invention is to provide a single cylinder internal combustion piston engine wherein the drive from the crank shaft to the output shaft is by way of a direct bevel gear and wherein the support of the crank shaft is by means of two widely spaced bearings, preferably ball bearings, both of which and the said bevel gear are disposed on one side of the crank, one bearing adjacent the crank and the other on the side of the bevel pinion remote from the crank so that the main structural parts of the engine consisting of the cylinder, crank case and gear box containing the said bevel gear may together form an L-shaped structure.

A further object of the invention is to obtain a smooth quiet drive with a spiral gear effect and with the bevel pinion preferably at one of the torsional vibration nodes of the crank shaft.

The invention further aims at a construction in which the members of the aforesaid L structure can be assembled components which are easy to inspect before assemblage and can be so constructed as to require but simple machining operations to make ready for use and to be readily assembled frictional spigot and faucet fashion with the aid of screw-nutted bolts. The jointing may be made tight by suitably choosing the unit contact pressure between machined metal surfaces or between these and suitable interposed packing.

The L shape of the engine as aforesaid enables it to fit very neatly in a cycle frame, for example, with the cylinder lying along the front down tube and the gear box lying along the rear down saddle tube or vice versa and the said output shaft may then be provided with a driving chain sprocket. Furthermore it is easy to arrange the mounting of the engine so that its centre of gravity lies on or substantially on a line passing through upper and lower points of suspension.

A further object of the invention is to construct the crank web for mass-balancing in such a manner as to allow for one of the bearings to be located close to the said web and so that the

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crank disc may be made very rigid and light in weight and conduces to easy balancing as well as to very small bending stresses by virtue of a very short lever arm between the centres of the crank pin bearing and the main bearing.

In the case of two-stroke engines the admission device for the combustible mixture may be designed as a diaphragm arranged on a grid shaped admission opening and held in position by a current limiting stop, the deflection of the diaphragm and thus the stresses of the diaphragm material at any point of the diaphragm being limited by the stop. This admission device may be arranged on the crank case cover, which latter may carry the carburettor and the air filter. The cover may form a part of the carburettor, for instance its casing, thus conducing to a simple, compact, robust and reliable construction. Likewise in the case of two stroke engines the lubricant is usually mixed with the petrol and the aforesaid arrangement of the admission device in the crank case cover has the advantage that the connecting rod bearing and crank shaft bearing are directly subjected to the gas stream of the petrol-oil mixture and are thus continuously lubricated and well cooled, ensuring long service life even under heavy load. The L-shape of the engine enables the crank case to be cast in one piece either with the cylinder or with the gear case. Either construction is favourable to manufacturing economies and weight reduction and increases the dimensional accuracy and rigidity of the motor.

Forming the cylinder and the crank case in one casting has the further advantage that the crank case may be fastened merely by clamping it between its cover and the gear box by bolting these two parts together. The transfer passages from the crank case to cylinder in the case of two-stroke engines may be conventionally formed in the casting, but to minimise expenditure of material and weight it is preferred to bore these transfer passages which assures their exact position and proper surface. This lessens the fuel consumption and the formation of eddies with resulting droplets from the gas mixture in two-stroke engines.

If the crank case and the gear box are combined in one casting, a shouldered down bottom of the cylinder can be received in a cylindrical extension of the crank case.

In either case the cylinder may be fitted with a liner. The cylinder head for two stroke engines is preferably fastened by means of screw-nutted bolts re-acting at points of the cylinder at the

level of the parts where the cylinder wall is of ample thickness. In this way a distortion of the more sensitive upper zone of the cylinder is avoided.

To mount this novel engine, e. g., into a pedal bicycle frame, two suspension points are provided preferably arranged on an axis passing through the centre of gravity, a third fastening point being provided to receive the reaction moments.

In order that the present invention may be the more readily understood reference is hereinafter made to the constructional form for a two stroke engine illustrated by way of example in the accompanying drawings, in which form—

Fig. 1 shows a longitudinal section through an engine according to the invention.

Fig. 2 represents a diagrammatic cross section through the cylinder crank case casting and

Fig. 3 shows a modified design, the crank case and gear box forming one casting.

Fig. 4 shows an enlarged view of the crank pin and big end bearing.

Fig. 5 shows a view of the engine mounted in the frame of a pedal bicycle.

Fig. 6 is an end view of the engine showing the method of bolting the main structural parts of the engine together.

Figs. 7 and 8 show an enlarged side view and sectional view of the disc crank.

Fig. 9 is a sectional view of the carburettor.

Fig. 10 a fragmentary view of the mixture admission device.

In Figs. 1 and 2 the cylinder 1 and the crank case 2 form one casting, the transfer passages 3 from the crank case to the cylinder admission ports being bored. One side of the crank case is closed by the cover 4, the other by the gear box 5 the case of which is formed by another casting. These parts are assembled by tie bolts 31 which clamp the crank case 2 between the flanges of the cover 4 and the casting 5 only through friction. This enables quick, simple and reliable assembling of the component parts.

The crank shaft 6 is supported exclusively by ball bearings in the end wall of the gear box 5. As shown the crank shaft 6 carries at one end the crank web 7 and at the other end the fly wheel magnet 8. A bevel gear is used. The bevel pinion 9 is fixed on the crank shaft at the vibration node, thus reducing wear and noise of the gearing to a minimum. The axis of the crank shaft is arranged with reference to the axis of the output shaft 13 so that the two do not intersect and the pinion directly engages the wheel to produce a spiral gear effect.

The cylinder and crank case casting on the one hand and the juxtaposed gear case with attached fly wheel magnet on the other hand—are arranged with the cylinder and gear box axes at right angles to one another in the shape of an L. One leg which on occasion may be the vertical leg of the L is formed by the cylinder and the other leg which on occasion may be the horizontal leg by the gear case, the latter being at right angles to the general plane of the disc crank. For fastening this unit e. g., in the frame of a bicycle, two suspension points 10 and 11 are provided on an axis through the centre of gravity. A third fixing point 12 may be provided to receive the reaction moments. In case the engine is used as a bicycle motor, a sprocket wheel is fixed on the shaft 13 driven from the crank shaft 6.

Though other designs are possible, it is advisable to combine the carburettor, the air filter and the admission device with the crank case cover 4. The crank case cover may be designed to enable the air filter 14 to be attached by clamping or otherwise fixed in an easily interchangeable manner in front of the carburettor 15, the latter in the illustrated example including part of the cover 4 which forms the carburettor casing 16. The admission device may consist of a diaphragm 17 held in position on grid shaped admission openings 18 in the cover 4 by a stop body 19 which limits the deflection of the diaphragm by a bent stop surface 19a. The position of the admission device will be preferably chosen such that the suction gas stream strikes the connecting rod bearing 20 and the main crank shaft bearing 21, thus lubricating and cooling these two bearings sufficiently even under heavy loading of the engine. The admission of the petrol-oil mixture to the rollers of the connecting rod bearing 20a may be facilitated by holes in the end plates 20b of this bearing. A central opening 22 may be provided through the crank pin to permit the passage of the gas stream to the main crank bearing 21. The crank web may consist of ordinary unalloyed steel to avoid detrimental distortion by heat treatment. The crank pin 60 projects from one face of the web 7 which is in the form of a disc, the other face of which has an annular recess 62 opening towards the gear box, the inner rim 63 of the recess forming the hub for receiving the end of the crank shaft and the disc having radial and axial mass-balancing extensions of the portion 64 of the outer rim 7a remote from the crank pin. The main bearing 21 is located in the recess between its inner face and a spigot portion 65 of the gear box intruding into the recess. A sufficient strength of the web is afforded by its double-U-shaped cross section. In the main bearing 21 is mounted the hub which is pushed on the crank shaft and is located for the most part within the outer rim 7a. In order to obtain the required surface hardness of the crank pin a hardened steel sleeve 24 may be pressed on to the pin. The thin-walled sleeve 24 is thoroughly hardened, thus avoiding the frequently insufficient case hardening depth of conventional crank pins. The cost of production is reduced by this arrangement because the price of hardened parts depends on their weight according to the required expenditure of heat. Besides the small sleeve can be properly centreless ground.

The structural parts not yet described, such as connecting rod 21, piston 23, cylinder head 29 etc., are of normal design. It is convenient and advantageous to fasten the cylinder head 29 on the cylinder 1 with the aid of tie bolts 30 which are fastened to the cylinder 1 at the level of the ports, i. e., at a point where the cylinder wall is of ample thickness, thus securing reliable reception of the retaining forces and avoiding the danger of the most sensitive upper zone of the cylinder barrel being distorted. The design and arrangement of some parts may be modified, e. g., the admission device could be arranged at the side of the crank case closed by the gear box 5. In this modification the arrangement may be such that the gas mixture may enter the crank case through the main crank bearing 21 lubricating on its way this bearing and the connecting rod bearing. In this case the carburettor and air filter could remain in their former position or could for instance be installed in the space

between the two legs of the L, by providing a suitable suction pipe to the crank case.

Fig. 3 shows a modification of the L-construction where gear box 6 and crank case 7 with cylindrical extension 8a form one casting. In this case a shouldered down crank case end of the cylinder 20 may be received in said extension 22 of the crank case. The contact surfaces between the cylinder shoulder (shown conical) and the corresponding mating part of the aforesaid extension are situated at the level of the ports, thus improving the heat transmission and avoiding distortions in the port region.

What I claim is:

1. A single cylinder internal combustion piston engine comprising a cylinder and a crank shaft the axes of which are at right angles to each other, a crank case, two bearings by which said crank shaft is supported, a power output shaft and a bevel reduction gear through which said crank shaft directly drives said output shaft a case containing said gear, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed in said gear case adjacent to the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed in said gear case adjacent to the said pinion and on the side of the pinion remote from the crank.

2. A single cylinder internal combustion piston engine comprising a cylinder and a crank shaft, the axes of which are at right angles to each other, two bearings supporting said crank shaft, a bevel reduction gear through which said crank shaft directly drives said output shaft, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging the said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed adjacent the crank and between the crank and the said bevel pinion and the other of said bearings being disposed adjacent to the said pinion in the half of the wheel remote from the crank, the crank being in the form of a disc having a crank pin projecting from one face of said disc, the opposite face of said disc having an annular recess forming an outer rim and an inner cylindrical hub in which the end of said crank shaft is fixed and on which seats the said bearing adjacent the crank, and said disc having radial and axial extensions of its outer rim remote from the crank pin to mass-balance the reciprocating parts of the engine.

3. An engine according to claim 2, comprising a connecting rod and a ball or roller bearing supporting said connecting rod on said crank pin.

4. An engine according to claim 2, said bevel reduction gear being in a case having a spigot which intrudes into said recess, said bearing adjacent the crank being a ball bearing located between said hub and said spigot.

5. A single cylinder internal combustion piston engine comprising a cylinder and a crank shaft the axes of which are at right angles to each other, two bearings supporting said crank shaft a power output shaft, a bevel pinion on said crank shaft and a bevel wheel on said power output shaft forming a direct reduction gear drive between the crank shaft and the output shaft, said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed adjacent to the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed adjacent to the said pinion and on the side of the pinion remote from the crank, a connecting rod and a bearing supporting said rod on the crank, a crank casing, a casing containing said bevel pinion and wheel, said latter case extending from one end of said crank casing, the other end of said crank casing being provided with a separate cover and means in said cover permitting the combustible mixture and lubricant to be led into the crank case so that the stream of mixture and lubricant cools and lubricates the said connecting rod bearing and the said crank shaft bearing adjacent the crank.

6. An engine according to claim 5, comprising a grid carried by said cover, a diaphragm normally covering said grid and arranged to be deflected off the grid for the passage of the mixture through the grid into the crank case and a dome-shaped member forming a stop for the diaphragm in its opening movement and limiting the said movement, said cover having an outward extension, and carburetter and mixture control means being carried by said extension.

7. An engine according to claim 1, in which the driving pinion of the bevel gear is located at a torsional vibration node of the crank shaft.

8. An engine according to claim 1, comprising a gear case containing said bevel gear and a flywheel magnet disposed on the end of said crank shaft remote from the crank and outside the gear case.

9. A single cylinder internal combustion piston engine comprising a cylinder and a crank shaft the axes of which are at right angles to each other, a crank case, two bearings by which said crank shaft is supported, a power output shaft and a bevel reduction gear through which said crank shaft directly drives said output shaft, a case containing said gear, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed in said gear case adjacent to the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed adjacent to the said pinion and on the side of the pinion remote from the crank, the axis of said crank shaft making a chord with said wheel and not intersecting the axis of the output shaft.

10. A single cylinder internal combustion piston engine comprising a cylinder and a crank shaft the axes of which are at right angles to each other, a crank case, two bearings by which said crank shaft is supported, a power output shaft and a bevel reduction gear through which said crank shaft directly drives said output shaft, a case containing said gear, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed in said gear case adjacent to the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed in said gear case adjacent to the said pinion and on the side of the pinion remote from the crank, said crank case and the case of said cylinder being formed from a single casting and said gear case being formed as another casting, said gear case casting being secured to one end and an end cover being fitted to the other end of the crank case.

11. A single cylinder internal combustion pis-

P-482

ton engine comprising a cylinder and a crank shaft the axes of which are at right angles to each other, a crank case, two bearings by which said crank shaft is supported, a power output shaft and a bevel reduction gear through which said crank shaft directly drives said output shaft, a case containing said gear, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed in said gear case adjacent to the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed in said gear case adjacent to the said pinion and on the side of the pinion remote from the crank, said crank case and said gear case being formed from a single casting and the case of said cylinder being formed from a separate casting and inserted in said combined crank case and gear case casting.

12. An engine according to claim 11, said crank and gear box casting having a cylindrical extension from the crank casing, said cylinder casing having a shouldered down portion which makes frictional spigot and faucet engagement with the crank casing, the joints between them being secured by bolting together.

13. A single cylinder internal combustion piston engine comprising a casing providing a cylinder and a crank shaft, the axes of which are at right angles to each other, a crank casing, two bearings by which said crank shaft is supported, a power output shaft and a bevel reduction gear through which said crank shaft directly drives said output shaft, a casing for said gear, said bevel reduction gear comprising a bevel pinion and a bevel wheel and said bevel pinion engaging said bevel wheel in the half of the wheel remote from the said cylinder axis, one of said bearings being disposed in said gear casing adjacent to

the crank and between the crank and the said bevel pinion and the other of the said bearings being disposed in said gear casing adjacent to the said pinion and on the side of the pinion remote from the crank, said crank casing being cast in one piece with one of said other casings, mixture admission ports in the cylinder casing, and transfer passages bored through the wall of the crank casing and leading from the crank casing to said ports.

14. An engine according to claim 13, comprising a cylinder head fastened by tie bolts to the cylinder casing substantially at the level of said mixture admission ports.

OTTO LUTZ.

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Feb. 10, 1953 L. D. BAKKE 2,627,940

INTERNAL-COMBUSTION ENGINE LUBRICATION

Filed Oct. 4, 1950 2 SHEETS—SHEET 1

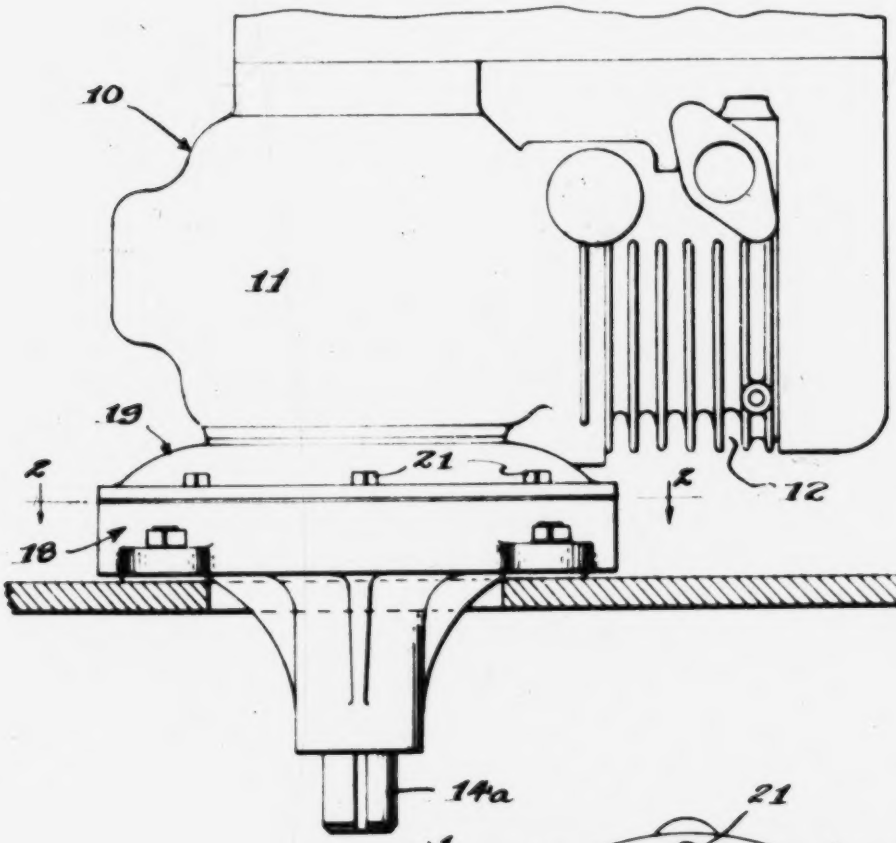

Fig. 1

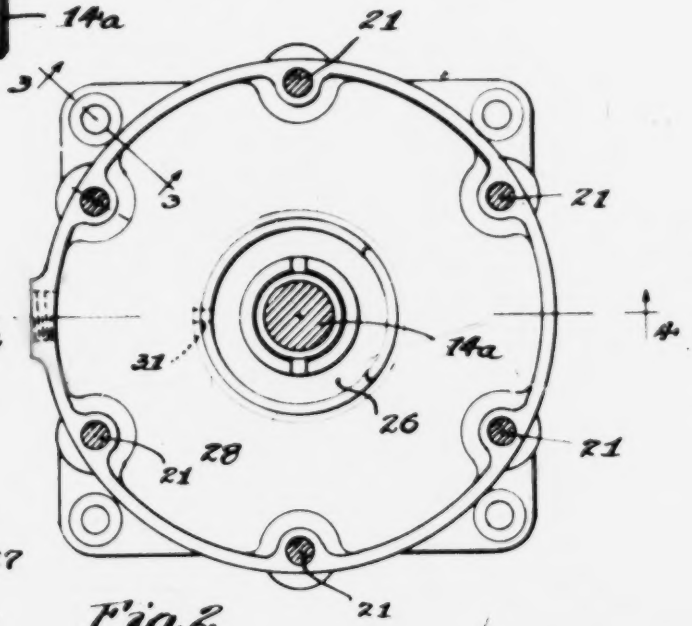

Fig. 2

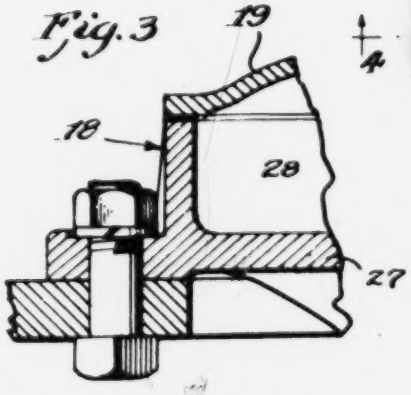

Fig. 3

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INTERNAL-COMBUSTION ENGINE LUBRICATION

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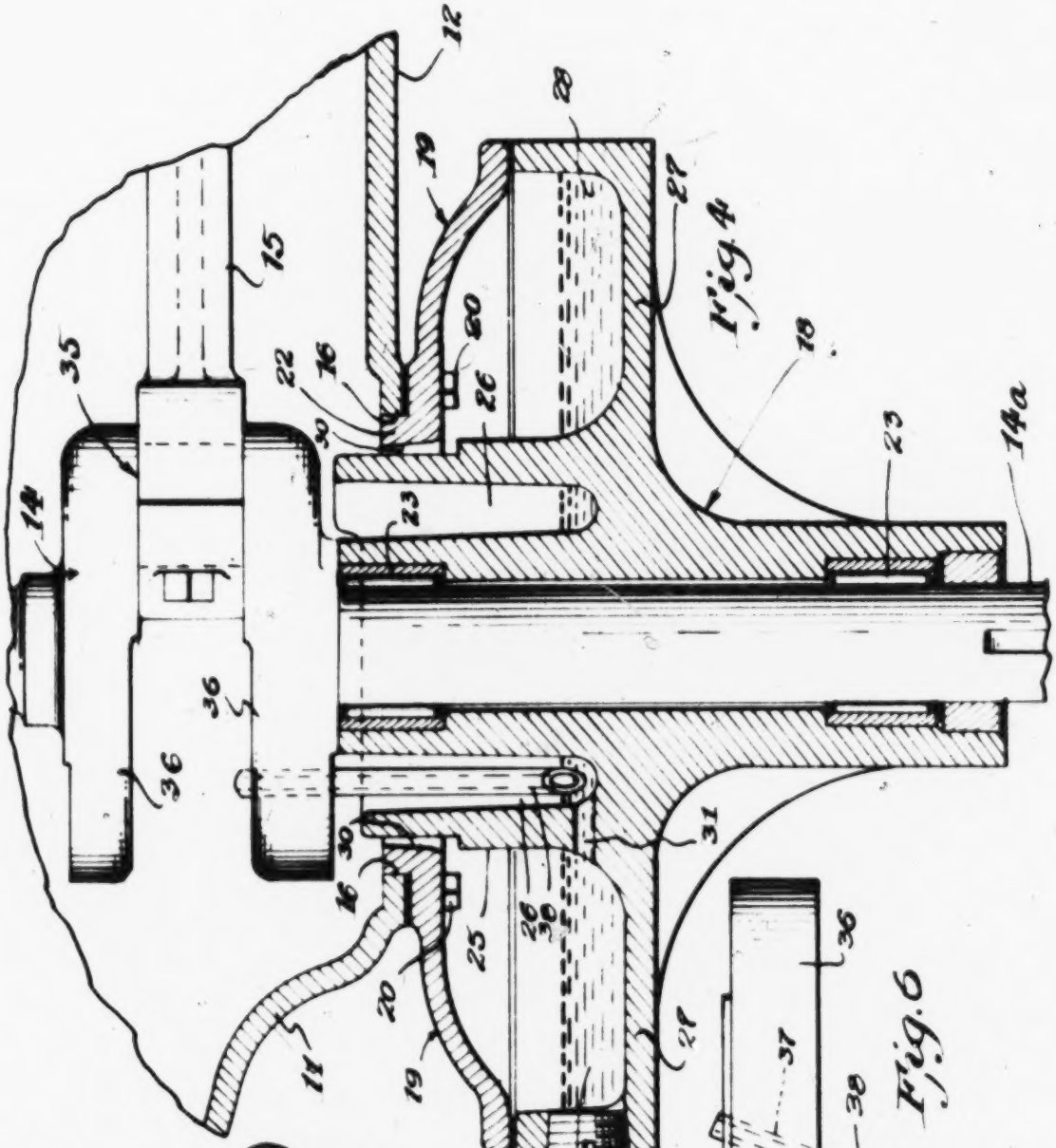

Fig. 4

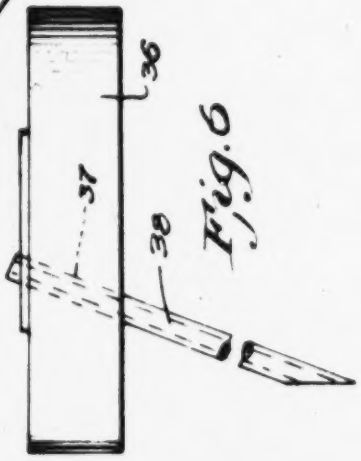

Fig. 6

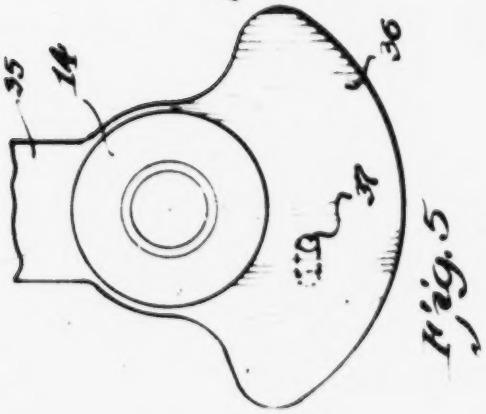

Fig. 5

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INTERNAL-COMBUSTION ENGINE LUBRICATION

Laurence D. Bakke, Plymouth, Mich., assignor to Continental Motors Corporation, Detroit, Mich., a corporation of Virginia

Application October 4, 1950, Serial No. 188,460

7 Claims. (Cl. 184—13)

1

My invention relates to internal combustion engines and more particularly to the lubricating system for engines of relatively small horsepower and size, and which comprises a vertically extending crankshaft.

The conventional crankcase oil sump is not applicable to engines of this type and usually some means for force feeding lubricating oil to the moving engine parts to be lubricated is embodied in such engines. The expense of a force feed lubrication system is a problem in connection with the manufacture and sale of such engines, because of the highly competitive nature of this type of engine. Most of this type of power plant embody only a single engine cylinder, and a splash lubrication system is quite adequate to lubricating such moving engine parts that require lubrication.

The present invention is aimed to overcome the lubrication difficulties present in this type of small engine, by providing a splash system applicable to engines having a vertically extending crankshaft.

Engines of this type have of late been quite widely used in powering rotary type power mowers, and the main object of the present invention is to overcome the lubrication problems by providing a simple and compact splash lubrication system which can be embodied in such engines with a minimum of labor and expense, and which requires a minimum of servicing.

For a more detailed understanding of my invention, reference may be had to the accompanying drawings illustrating a preferred embodiment of the invention in which like parts throughout the several views are identified by like reference characters, and in which

Fig. 1 is an elevational view of an engine incorporating the principles of my invention.

Fig. 2 is a plan detail view of the crankcase closure element which carries the crankshaft bearings with the adapter removed.

Fig. 3 is a detail sectional view taken on the line 3—3 of Fig. 2, but showing the means for securing the engine to its support and the relation of the adapter to said closure element.

Fig. 4 is a fragmentary vertical sectional view through the engine crankcase and closure assembly and taken generally in the plane indicated by section 4—4 of Fig. 2.

Fig. 5 is a fragmentary detail of the crankshaft showing the counterweight and the relation thereto of the dipper tube, and

Fig. 6 is an edge elevation thereof showing the dipper tube and taken substantially normal to the showing thereof in Fig. 4.

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The engine herein illustrated comprises a crankcase and cylinder casting 10, preferably consisting of a crankcase portion 11 and a finned engine cylinder 12. This engine is a conventional piston engine, and the piston (not shown) is operable in the cylinder 12 and is connected with the engine crankshaft 14 by a conventional connecting rod 15. This crankshaft extends generally vertical and projects through the opening 16 in the wall of the crankcase.

A closure structure is secured to the crankcase and comprises a flanged crankshaft bearing plate 18 and an adapter 19, said adapter being secured to the crankcase by suitable bolts 20 and to the plate 18 by suitable bolts 21. The adapter is provided with a machined boss 22 piloted in the crankcase opening 16 to axially locate and position the plate 18 to align the crankshaft bearings 23 with the crankshaft extension 14a.

The plate 18 is constructed with a hub portion 25 provided with an annular recessed oil pocket 26 arranged concentric with the crankshaft axis. It is also constructed with a saucer like flange 27 providing an oil sump 28. The outer rim 29 of this flange 27 receives the peripheral rim of the adapter 19 and suitable gaskets are employed between the plate and adapter and between the adapter and crankcase (see Fig. 4).

It will be observed that the hub portion 25 of the plate extends or projects through the crankcase opening 16 and through the opening 30 in the adapter 19, and that this opening 30 is greater than the outside diameter of the hub portion 25 so as to permit oil to drain by gravity from the interior of the crankcase 11 into the oil sump 28. A hole 31 connects the sump 28 with the annular recess or trough 26, so as to meter an adequate flow of oil from the sump to the trough.

The crankshaft may be forged of an integral structure or the crankshaft extension 14a may be a separate shaft from the crankshaft proper and rigidly secured thereto in any known manner. The crankshaft 14 carries a crank portion 35 and a pair of counterweights 36 preferably oppositely disposed with respect to the crank portion. The counterweighted portion 36 of the crankshaft most closely adjacent to the bottom of the crankcase is provided with a sloping hole 37 in which is securely fixed a dipper tube 38. This dipper tube is moved round and round through the trough 26 and picks up or scoops up the lubricating oil from said trough and discharges same into the crankcase interior. Pref-

crably this dipper tube directs the oil generally towards the other counterweight 36, the oil stream discharged therefrom being broken up into a mist which circulates around in the crankcase and to the moving engine parts which require such lubrication.

It will be apparent to those versed in the art to which my invention pertains, that, though I have illustrated but one embodiment of the invention, various changes and modifications may be made in structure without departing from the spirit of my invention or from the scope of the appended claims.

I claim:

1. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for the crankcase opening and provided with an oil sump portion and chamber openly communicating with the crankcase interior through the said opening and with an annular recessed lubricant collecting trough communicating with said oil sump portion and disposed substantially concentric with respect to the crankshaft axis, and a dipper carried by said crankshaft and disposed to travel in said trough and to scoop lubricating oil out of said trough and discharge same into the crankcase interior to lubricate moving engine parts.

2. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for said crankcase opening and provided with a lubricant sump and chamber openly communicating with the crankcase interior through the said opening and with an annular trough communicating with said oil sump and disposed substantially concentric with respect to the crankshaft axis, said closure structure having an opening connecting said trough with said lubricant sump, and a dipper carried by said crankshaft and disposed to travel in said trough and to scoop lubricating oil out of said trough and discharge same directly into the crankcase interior to lubricate moving engine parts.

3. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for the crankcase opening comprising a member having a hub portion carrying crankshaft bearing means and having an outwardly flanged saucer-like portion providing a lubricant sump around said hub portion, and an adapter piloted in said crankcase opening and secured to said member and serving to axially align the crankshaft bearing means with said crankshaft, said hub portion provided with an upwardly opening annular trough connected with the lubricant sump, and a dipper carried by said crankshaft and disposed to travel in said trough and to scoop lubricating oil out of said trough and to discharge same directly into the crankcase interior to lubricate moving engine parts.

4. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for the crankcase opening comprising a member having a hub portion carrying crankshaft bearing means and having an outwardly flanged saucer-like portion providing a lubricant sump around said hub portion, and an adapter piloted in said crankcase opening and secured to said member and serving to axially align the crankshaft bearing means with said crankshaft, said hub portion projecting into said crankcase opening and provided with an upwardly opening annular trough open inwardly of the crankcase interior and connected with the lubricant sump, and a dipper carried by said crankshaft and disposed to travel in said trough and to scoop lubricating oil out of said trough and to discharge same directly into the crankcase interior to lubricate moving engine parts.

5. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for the crankcase opening comprising a member having a hub portion carrying crankshaft bearing means and having an outwardly flanged saucer-like portion providing a lubricant sump around said hub portion, and an adapter piloted in said crankcase opening and secured to said member and serving to axially align the crankshaft bearing means with said crankshaft, said hub portion projecting into said crankcase opening and provided with an annular trough open inwardly of the crankcase interior and connected with the lubricant sump, and a dipper carried by said crankshaft and disposed to travel in said trough and to scoop lubricating oil out of said trough and to discharge same directly into the crankcase interior to lubricate moving engine parts, said adapter having an opening encircling said hub portion and spaced from the external surface of said hub to provide an opening permitting lubricant to drain from said crankcase interior into said lubricant sump, the outer peripheral rim of said adapter being joined with the outer peripheral rim of said saucer like portion of the closure structure member.

6. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, a closure structure for the crankcase opening comprising a member having a hub portion carrying crankshaft bearing means and having an outwardly flanged saucer like portion providing a lubricant sump around said hub portion, and an adapter piloted in said crankcase opening and secured to said member and serving to axially align the crankshaft bearing means with said crankshaft, said hub portion projecting into said crankcase opening and provided with an annular trough open inwardly of the crankcase interior and connected with the lubricant sump, said crankshaft having a crank portion and a counterweighted portion, and a dipper carried by said counterweighted portion and disposed to travel in said trough and to scoop lubricating oil out of said trough and to discharge same directly into the crankcase interior to lubricate moving engine parts.

7. In an internal combustion engine having a vertically extending crankshaft, a crankcase having a bottom opening through which said crankshaft extends, said crankshaft having a crank portion and counterweighted portions extending oppositely to the offset crank portion, a closure structure secured to the crankcase to enclose the bottom opening of the crankcase, said closure structure having a saucer-like lubricant sump portion and a hub portion supporting the crankshaft, said hub portion having an annular trough concentric with respect to the crankshaft axis and communicated with said lubricant sump portion, and a dipper tube carried by said counterweighted portion most closely adjacent to said hub portion of said closure member and projected

into said annular trough, said dipper tube arranged to travel in said trough and to scoop lubricating oil out of said trough and to discharge same generally toward said other counter weighted portion of the crankshaft and into the crankcase interior to lubricate moving engine parts.

LAURENCE D. BAKKE.

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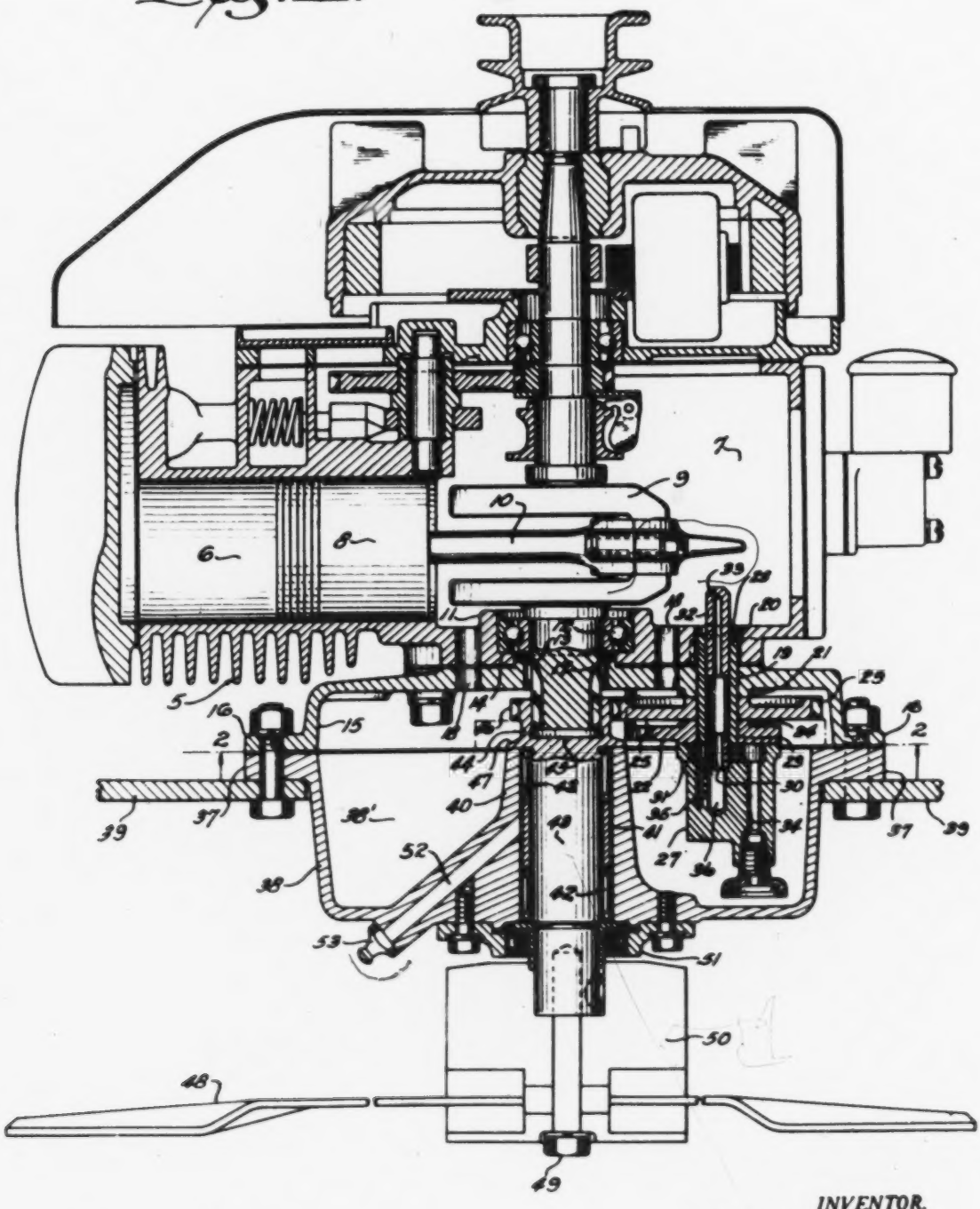
March 10, 1953 A. S. BOSMA 2,630,881

INTERNAL-COMBUSTION ENGINE CONSTRUCTION

Filed April 15, 1949 2 SHEETS—SHEET 1

Fig. 1.



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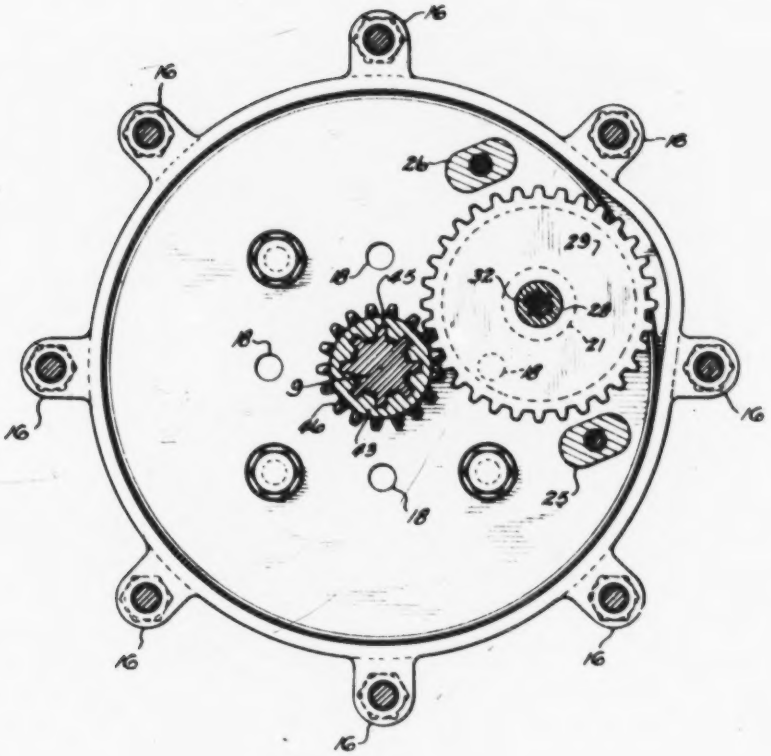
INTERNAL-COMBUSTION ENGINE CONSTRUCTION

Filed April 15, 1949 2 SHEETS—SHEET 2

Fig. 2.



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Patented Mar. 10, 1953

2,630,881

UNITED STATES PATENT OFFICE

2,630,881

INTERNAL-COMBUSTION ENGINE CONSTRUCTION

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Application April 15, 1949, Serial No. 87,770

20 Claims. (Cl. 184—6)

1

This invention relates to improvements in internal combustion engine construction.

There are many applications wherein it is desirable to use an internal combustion engine having a vertically extending crankshaft connected to a vertically extending driven shaft for the purpose of transmitting power to a certain implement, fan blade, pump impeller, machine or other device requiring a drive of this type.

Since the pistons of this type of engine are horizontally disposed, a conventional splash type of lubrication system cannot be used. In addition, this type of engine must ordinarily be as compact as possible, while at the same time being so constructed as to effectively withstand any shock loads and/or vibration to which the driven member is subjected.

With the above in mind, it is therefore a general object of the invention to provide an improved construction for an internal combustion engine having a vertically extending crankshaft and having a vertically extending driven shaft wherein an annular oil sump is positioned below the crankcase and surrounding the driven shaft and into which oil can drain from the crankcase, said sump housing a gear type oil pump which is driven from said driven shaft.

Another object of the invention is to provide an engine construction of the class described wherein a relatively large driven shaft may be used and wherein the driven shaft and the crankshaft are connected in a manner to compensate for any misalignment thereof to thereby effectively prevent excessive wear on the engine due to shock loads and/or vibration to which the driven shaft is subjected.

Another object of the invention is to provide an engine construction of the class described having an upstanding boss formed in the bottom of the sump thereof and surrounding the driven shaft, said boss extending to a point near the level of the oil in said sump and forming a mounting for said driven shaft.

A further object of the invention is to provide an engine construction of the class described having a driven shaft formed at its upper end with an annular shoulder which rests on the upper end of the upstanding sump boss to vertically support said shaft, the upper end of said driven shaft also being formed with a recess having internal teeth for splined engagement with the crankshaft and being formed with external gear teeth which coact with the oil pump drive gear to drive said pump.

A further object of the invention is to provide

2

a construction of the class described wherein the oil pump is mounted on the underside of the sump cover, said pump having a tubular drive shaft which rotatably extends through alined apertures in the sump cover and bottom of the crankcase and having an oil discharge nozzle which rotatably projects into the crankcase to intermittently direct oil at the engine crank pin during engine operation.

A further object of the invention is to provide an engine construction of the class described which is compact, which is easily assembled and disassembled, and which is otherwise well adapted for the purposes described.

With the above and other objects in view, the invention consists of the improved internal combustion engine construction, and all of its parts and combinations, as set forth in the claims, and all equivalents thereof.

In the drawing accompanying and forming a part of this specification wherein is shown one complete embodiment of the preferred form of the invention, and wherein the same reference characters indicate the same parts in both of the views:

Fig. 1 is a vertical sectional view through an internal combustion engine embodying the improved construction; and

Fig. 2 is a transverse sectional view taken approximately through the line 2—2 of Fig. 1.

Referring more particularly to Fig. 1 of the drawing, the numeral 5 indicates an engine block having a horizontally disposed cylinder 6 and having a crankcase 7. A piston 8 is slidably positioned in the cylinder 6 and is connected to a vertically extending crankshaft 9 by a connecting rod 10. The bottom of the crankcase 7 is formed with an upstanding boss 11 which is bored to receive the crankshaft and a lower crankshaft bearing 12. The bore of the boss 11 has a portion of reduced diameter 13 to form a shoulder 14 on which the bearing 12 rests.

A sump cover plate 15, which is generally circular in shape, having substantially vertical sidewalls and having a plurality of outwardly projecting apertured lugs 16, is bolted to the underside of the crankcase. The sump cover plate 15 is formed with an upstanding bored boss 17 which fits into the bore 13 of the crankcase and through which the lower end of the crankshaft 9 extends. It will be noted that the bore of the boss 17 is larger than the diameter of the portion of the crankshaft thereadjacent.

The bottom of the crankcase 7 and the sump cover plate are formed with alined drain open-

ings 18, as well as with the alined openings 19 and 20, the latter being of slightly larger diameter than the former. The underside of the sump cover 15 is formed with a boss 21 surrounding the aperture 19 as shown in Fig. 1.

An oil pump mounting plate or bracket 22 extends horizontally and is spaced below the underside of the sump cover 15. The plate 22 is formed with a vertical aperture 23 which is coaxial with the aperture 19 in the cover 15. The plate 22 is formed with an upstanding boss 24 surrounding the aperture 23. The plate 22 is held in position by upstanding lugs 25 and 26 (see Fig. 2) formed at the ends thereof and bolted to the cover plate 15. A gear type oil pump 27 is fixed to the underside of the plate 22.

A tubular drive shaft 28 is rotatably positioned in the bores 19, 20 and 23, and fixed to said shaft between the bosses 21 and 24 is a pump drive gear 29. A sleeve 30 is preferably splined to the bore of one of the pump impeller gears 31 and to the lower end of the drive shaft 28. Fixedly positioned in the upper end of the drive shaft 28 is a tube 32 having its upper end closed and having said closed end formed with an angularly extending passage 33. The tube 32 forms a nozzle which rotates with the tubular drive shaft 28 during engine operation.

The oil pump 27 has an inlet passage 34 and an outlet passage 35. The outlet passage 35 extends downwardly and communicates with a bore 36 which, in turn, communicates with the bore of the sleeve 30 to provide a passage for oil under pressure to be delivered to the nozzle 32 through the drive shaft 28.

Bolted to the flanges 16 of the sump cover 15 are matching flanges 37 formed on a bowl-shaped sump or reservoir casing 38. The connecting bolts may also removably fix the entire engine, through the flanges 16 and 37, to a suitable supporting plate 39, as shown. The sump casing 38 is formed with a centrally disposed upstanding bearing boss 40 which is formed with an axial bore 41. The boss 40 forms an annular sump chamber 38' within the casing 38. The axis of the bore 41 is coincident with the axis of the crankshaft 9, and the boss 40 preferably extends substantially to the plane of the upper surface of the flange 37, as shown.

Positioned within the bore 41 of the boss 40 are suitable shaft bearings 42, and mounted for rotation in the bearings 42 is a relatively short driven shaft 43 having a relatively large diameter. The driven shaft 43 has an enlarged upper end 44 which is positioned above the upper end of the boss 40. The end portion 44 is formed with an end recess 45 having internal splines which engage external splines on the lower end of the crankshaft 9. The end portion 44 is also formed with external gear teeth 46 which engage the teeth of the oil pump drive gear 29, and with an outwardly projecting annular flange or shoulder 47 which engages the upper end of the boss 40. It is apparent that the driven shaft 43 is supported against lateral or axial downward movement by the boss 40 and the bearings 42.

The driven shaft 43 extends downwardly below the sump casing 38 and may be suitably connected to a device to be driven thereby. Fig. 1 shows a horizontal type lawn mower blade 48 connected to the shaft 43 by suitable means including a bolt 49 and a hub 50, the latter being keyed to the shaft 43. A suitable bearing cap and shaft seal assembly 51 may surround the shaft 43 at the underside of the sump casing 38

and be bolted to said casing as shown. A suitable passage 52 may be formed in the casing 38 to communicate between the bore 41 and an exterior lubricant fitting 53.

Operation of the engine causes rotation of the crankshaft 9 and of the driven shaft 43 splined thereto. The shaft 43, through the gear teeth 46, drives the oil pump drive gear 29 which, in turn, rotates the tubular drive shaft 28, the tube 32, and the impeller gear 31. Rotation of the intermeshing oil pump impeller gears causes lubricating oil to be drawn from the sump 38' into the inlet passage 34 and forces said oil out the outlet passage 35. This oil under pressure passes into the bore 36, through the sleeve 30, through the bore of the drive shaft 28, and tube 32, and is discharged out of the passage 33.

When the tube or nozzle 32 is in the position of Fig. 1 it directs a stream of lubricating oil at the crankpin of the crankshaft 9. However, since the nozzle 32 is rotating with the oil pump drive shaft 28 during engine operation, it directs oil at the crankpin only intermittently, i. e., once each revolution. Sufficient lubrication is obtained by this construction, and the operation is much more economical than if oil were continuously directed at the crankpin.

The oil in the crankcase 7 flows back to the sump 38' through the apertures 18, and since one of the apertures 18 drains oil onto the gear 29, sufficient lubrication is provided for said gear and the gear teeth 46 meshing therewith, as well as for the splined connection between the crankshaft 9 and the driven shaft 43. The level of the lubricating oil in the sump is preferably below the upper end of the boss 40.

It is apparent that the improved construction provides a very compact engine which is easily assembled or disassembled. By merely removing the sump casing 38 from the cover plate 15 the driven shaft 43 can be disengaged from the crank shaft and the pump drive gear 29. The novel mounting of the driven shaft within the sump casing 38, and the toothed connection of said shaft at its upper end with both the crankshaft and the oil pump drive gear not only makes for compactness and ease of assembly and disassembly, but it has other marked advantages. Among these advantages are the fact that a relatively large driven shaft may be used, thereby increasing the shock load which said shaft will withstand. The splined connection compensates for any misalignment between the crankshaft and the driven shaft and reduces vibration which would otherwise result during operation.

Various changes and modifications may be made without departing from the spirit of the invention, and all of such changes are contemplated, as may come within the scope of the claims.

What I claim is:

1. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having a toothed driving connection with said crankshaft above said boss, said connection being disengageable by relative movement axially of said shafts, and said driven shaft

having shoulder means supported on an upper end portion of said boss to support said driven shaft against vertical downward movement, said driven shaft also having a lower end portion accessible from below the reservoir for connection with an element to be driven thereby.

2. In an internal combustion engine having a crankcase, a vertically extending crankshaft mouhted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having a driving connection with said crankshaft above said boss, and said driven shaft being formed with an annular shoulder supported on the upper end of said boss to prevent vertical downward movement of said driven shaft, said shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

3. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; a centrally disposed, upstanding, vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having a splined connection with said crankshaft above said boss, and said driven shaft having shoulder means in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

4. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an oil pump in said reservoir mounted on said cover portion and having a drive gear; an upstanding vertically bored boss formed in the bottom of said bowl portion; and a driven shaft rotatably mounted in said boss, said driven shaft having a toothed connection with said crankshaft and with said oil pump drive gear above said boss, said toothed connections being disengagable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and said oil pump drive gear.

5. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; a centrally disposed, upstanding, vertically bored boss formed in the bottom of said bowl portion

and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having shoulder means in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, and said driven shaft having a splined connection with said crankshaft above said boss, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft.

6. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an upstanding vertically bored boss formed in the bottom of said bowl portion and projecting to the upper portion thereof; an oil pump mounted in said reservoir and having a drive gear; and a driven shaft rotatably mounted in said boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in driving engagement with said pump drive gear, the connections between the driven shaft and said crankshaft and oil pump gear being disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and from said oil pump gear.

7. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an upstanding vertically bored boss formed in the bottom of said bowl portion and projecting to the upper portion thereof; an oil pump in said reservoir fixed to the cover portion thereof and having a drive gear; and a driven shaft rotatably mounted in said boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in driving engagement with said pump drive gear, said driven shaft also being formed with an annular shoulder in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, the connections between the driven shaft and said crankshaft and oil pump gear being disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and from said oil pump gear.

8. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having an externally splined lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an upstanding vertically bored boss formed in the bottom of said bowl portion and

projecting to the upper portion thereof; an oil pump mounted in said reservoir and having a drive gear and a driven shaft rotatably mounted in said boss, said driven shaft at its upper end having an internally splined recess in which the lower end of said crankshaft is removably positioned and said driven shaft at its upper end also being formed with external gear teeth and with an external annular shoulder, said shoulder being positioned in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, and said external gear teeth drivingly engaging said pump drive gear, the connections between the driven shaft and said crankshaft and oil pump gear being disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and from said oil pump gear.

9. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; a gear type oil pump mounted in said reservoir and having a tubular drive shaft through which said pump discharges oil, said drive shaft having a nozzle at one end which rotatably projects into said crankcase to intermittently direct a stream of oil at said crankshaft during operation; and a driven shaft rotatably mounted in said reservoir and having a driving connection with said crankshaft and with said oil pump drive shaft in said reservoir, said connections being disengageable by relative movement axially of said shafts, said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

10. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; a gear type oil pump mounted in said reservoir and having a tubular drive shaft through which said pump discharges oil, said drive shaft having a nozzle at one end which rotatably projects into said crankcase, said nozzle being formed with an angularly disposed discharge passage for directing a stream of oil at said crankshaft when said passage is alined therewith; and a driven shaft rotatably mounted in said reservoir and having a driving connection with said crankshaft and with said oil pump drive shaft in said reservoir, said connections being disengageable by relative movement axially of said shafts, said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

11. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; a gear type oil pump mounted in said reservoir and having a tubular drive shaft having a nozzle at one end which rotatably projects into said crankcase to intermittently direct a stream of oil at said crankshaft during operation; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a driving connection with said crankshaft and with said oil pump drive shaft above said boss, said connections being disengageable by relative movement axially of said shafts, and said driven shaft having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

12. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; a gear type oil pump mounted in said reservoir and having a tubular drive shaft having a nozzle at one end which rotatably projects into said crankcase, said nozzle being formed with an angularly disposed discharge passage for directing a stream of oil at said crankshaft when said passage is alined therewith; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a driving connection with said crankshaft and with said oil pump drive shaft above said boss, said connections being disengageable by relative movement axially of said shafts, and said driven shaft having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

13. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; a gear type oil pump mounted in said reservoir and having a tubular drive shaft having a nozzle at one end which rotatably projects into said crankcase to intermittently direct a stream of oil at said crankshaft during operation; an oil pump drive gear fixed to said tubular drive shaft; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in driving engagement with said pump drive gear, and said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

14. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; a gear type oil pump mounted in said reservoir and having a tubular drive shaft having a nozzle at one end which rotatably projects into said crankcase, said nozzle being formed with an angularly disposed discharge passage for directing a stream of oil at said crankshaft when said

passage is alined therewith; an oil pump drive gear fixed to said tubular drive shaft; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in driving engagement with said pump drive gear, and said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby.

15. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an upstanding vertically bored boss formed in the bottom of said bowl portion and projecting to the upper portion thereof; a gear type oil pump in said reservoir fixed to the cover portion thereof and having a tubular drive shaft which projects through said cover and a portion of the bottom wall of the crankcase, said drive shaft having a nozzle at its upper end which rotatably projects into said crankcase to intermittently direct a stream of oil at said crankshaft during operation; an oil pump drive gear fixed to said tubular drive shaft; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in drive engagement with said oil pump drive gear, said driven shaft also being formed with an annular shoulder in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, and said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby, the connections between the driven shaft and said crankshaft and oil pump gear being disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and from said oil pump drive gear.

16. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an upstanding vertically bored boss formed in the bottom of said bowl portion and projecting to the upper portion thereof; a gear type oil pump in said reservoir fixed to the cover portion thereof and having a tubular drive shaft which projects through said cover and a portion of the bottom wall of the crankcase, said drive shaft having a nozzle at its upper end which rotatably projects into said crankcase, said nozzle being formed with an angularly disposed discharge passage for directing a stream of oil at said crankshaft when said passage is alined therewith to intermittently direct a stream of oil at said crankshaft during operation, an oil pump drive gear fixed to said tubular drive shaft; and a driven shaft rotatably mounted in the reservoir boss, said driven shaft having a splined connection with said crankshaft above said boss and being formed with external gear teeth adjacent said splined connection in driving engagement with said oil pump drive gear, said driven shaft also being formed with an annular shoulder in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, and said driven shaft also having a lower end portion projecting below the reservoir for connection with an element to be driven thereby, the connections between the driven shaft and said crankshaft and oil pump gear being disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft and from said oil pump drive gear.

17. In an internal combustion engine having a crankcase; a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall of the crankcase; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects; an upstanding vertically bored boss formed in the bottom of said reservoir and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having a driving connection with said crankshaft, and said driven shaft having shoulder means supported on an upper end portion of said boss to support said driven shaft against vertical downward movement, said driven shaft also having a lower end portion accessible from below the reservoir for connection with an element to be driven thereby.

18. In an internal combustion engine having a crankcase; a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; an oil pump in said reservoir mounted on said cover; an upstanding vertically bored boss formed in the bottom of said bowl portion; and a driven shaft rotatably mounted in said boss; said driven shaft having a driving connection with said crankshaft and with said oil pump above said boss, said driving connection being of a type which is disengageable by relative movement axially of said shafts, whereby removal of the bowl portion of the reservoir from the cover portion causes simultaneous disengagement of the driven shaft from the crankshaft and oil pump drive gear.

19. In an internal combustion engine: a crankcase having a bottom wall; an oil reservoir below said crankcase, said reservoir having a separable bowl portion; a vertically extending crankshaft mounted in the crankcase and having its lower end portion projecting through the bottom wall of the crankcase and into the oil reservoir; an oil pump unit mounted in the reservoir, said oil pump unit including: an oil pump having a tubular drive shaft projecting vertically upwardly therefrom through which said pump discharges oil, and a drive gear on said drive shaft, said drive shaft having a nozzle at its upper end rotatably and axially slidably projecting through the bottom wall of the crankcase into said crankcase; and a driving connection in said reservoir between said crank-

shaft and oil pump drive gear, said driving connection being of the type which is disengageable by axial movement of said drive gear, whereby removal of the bowl portion of the reservoir permits removal of the oil pump unit from the engine by downward movement of said unit axially of said drive gear, said movement causing disengagement of the driving connection and withdrawal of the nozzle from the crankcase.

20. In an internal combustion engine having a crankcase, a vertically extending crankshaft mounted in said crankcase and having its lower end portion projecting through the bottom wall thereof; an oil reservoir below said crankcase and into which the lower end portion of the crankshaft projects, said reservoir being separable into a bowl portion and a cover portion; a centrally disposed, upstanding, vertically bored boss formed in the bottom of said bowl portion and projecting to the upper portion thereof; and a driven shaft rotatably mounted in said boss, said driven shaft having shoulder means in engagement with the upper end of said boss to support said driven shaft against vertical downward movement, and said driven shaft having a splined connection with said crankshaft whereby removal of the bowl portion of the reservoir from the cover portion thereof permits simultaneous disengagement of the driven shaft from the crankshaft.

ALFRED S. BOSMA.

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Feb. 16, 1954 H. S. BROWN 2,669,322

SPLASH TYPE LUBRICATING DEVICE FOR SINGLE CYLINDER HORIZONTAL INTERNAL-COMBUSTION ENGINES

Filed June 30, 1952 2 Sheets-Sheet 1

Fig. 1.

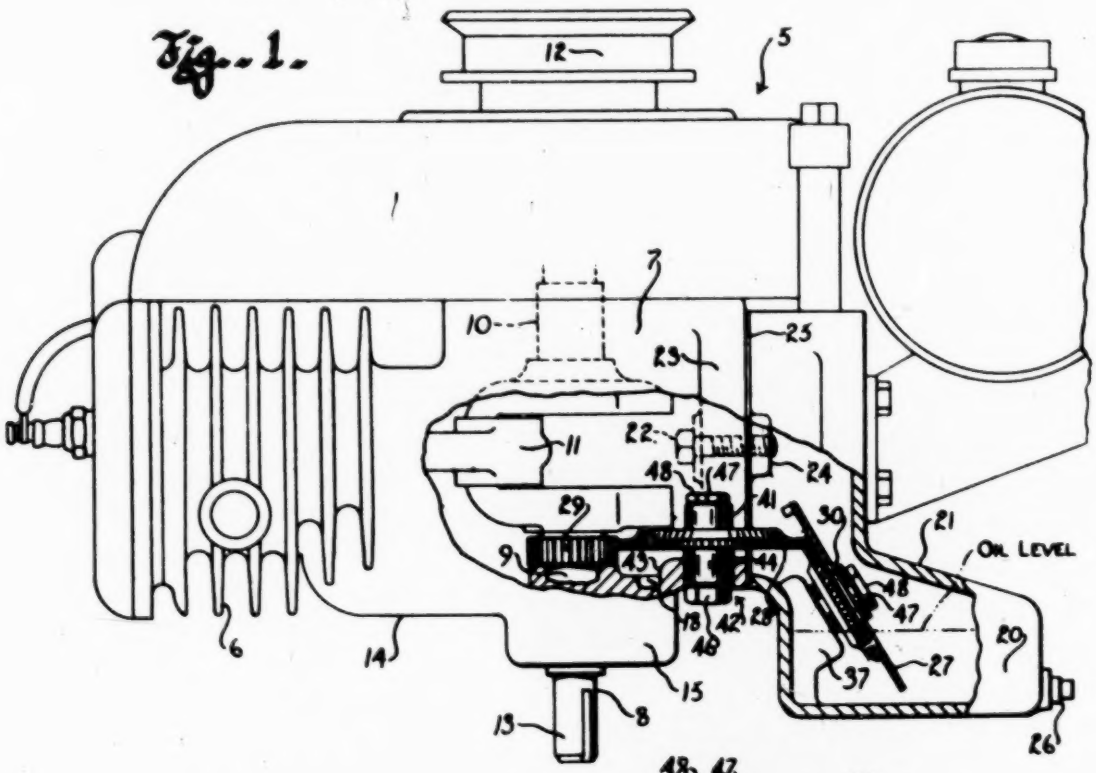


Fig. 2.

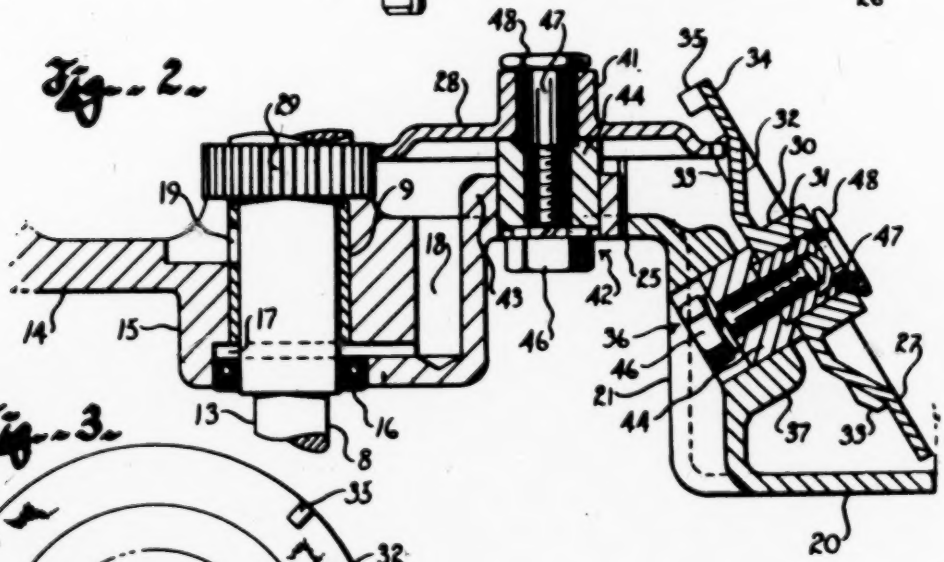
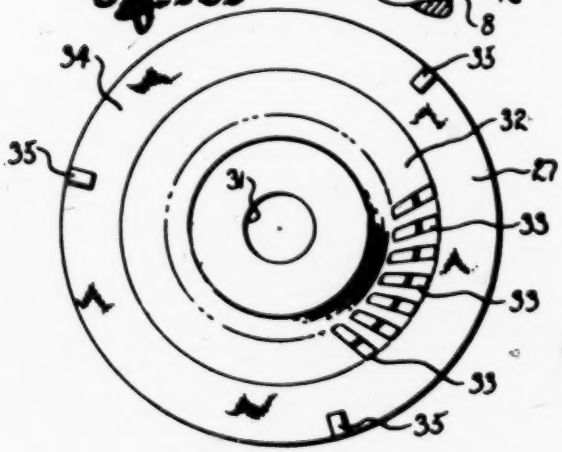


Fig. 3.



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SPLASH TYPE LUBRICATING DEVICE FOR SINGLE CYLINDER HORIZONTAL INTERNAL-COMBUSTION ENGINES

Filed June 30, 1952 2 Sheets-Sheet 2

Fig. 4.

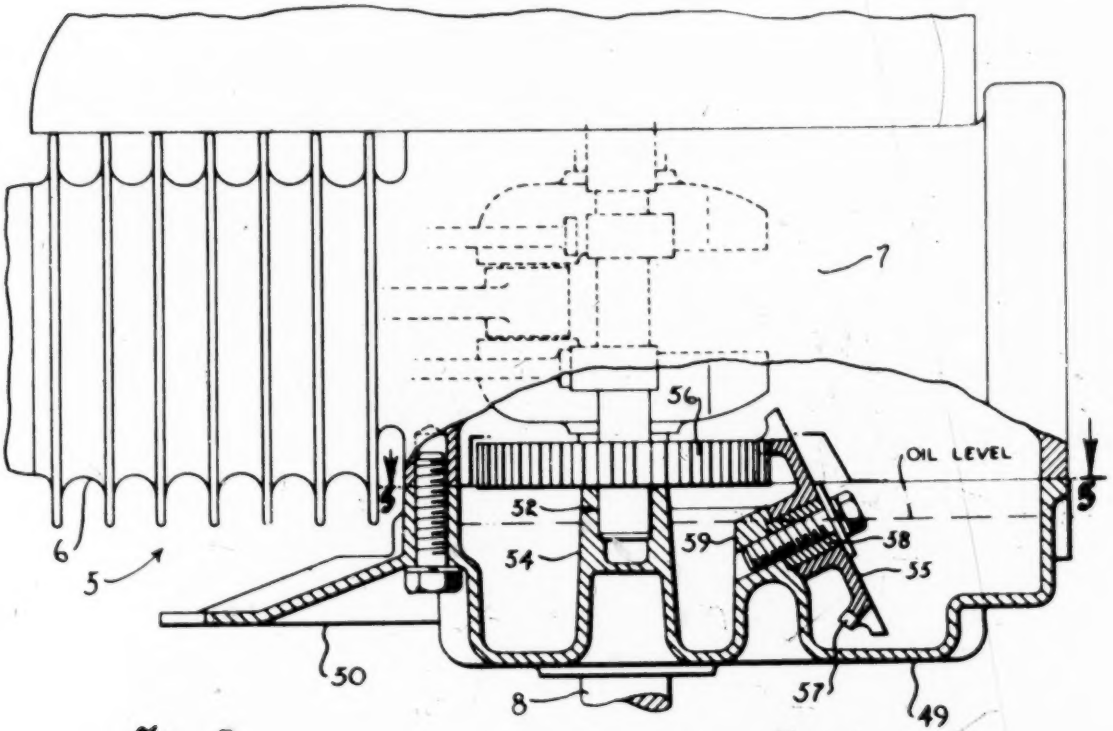


Fig. 5.

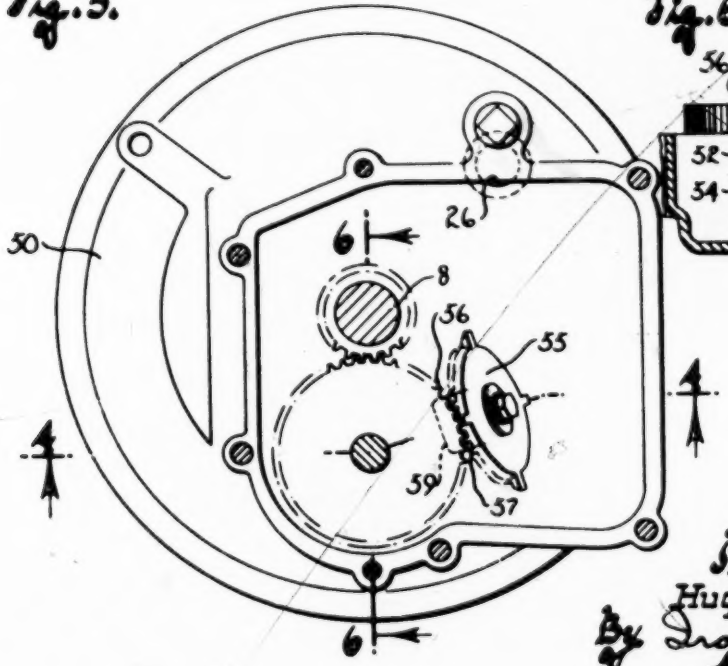
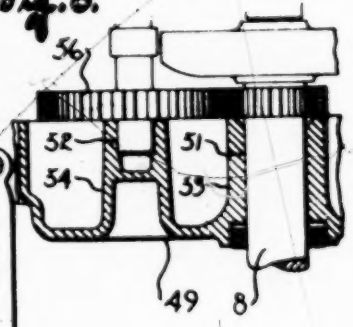


Fig. 6.



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Patented Feb. 16, 1954

2,669,322

UNITED STATES PATENT OFFICE

2,669,322

SPLASH TYPE LUBRICATING DEVICE FOR SINGLE CYLINDER HORIZONTAL INTERNAL-COMBUSTION ENGINES

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Application June 30, 1952, Serial No. 296,393

6 Claims. (Cl. 184—13)

1

This invention relates to splash type lubricating devices for internal combustion engines and refers more particularly to a device for the internal lubrication of small single cylinder horizontal engines in which the crankshaft is disposed on a vertical axis. The vertical disposition of their crankshafts adapts these engines to many uses not too well served by the more conventional upright engines, rotary power lawn mowers for instance. But in such horizontal engines the crankcase itself must be specially designed to prevent the supply of internal lubricating oil leaking out through the lower crankshaft bearing, especially when the engine is idle.

Moreover, unless the bottom of the crankcase is disposed well below the cylinder, the oil level in the crankcase would often be above the mouth of the cylinder, and oil would then seep through the piston rings and, of course, foul the engine. It is, therefore, necessary, in an engine having a vertical crankshaft, to provide an oil sump so disposed that the level of the oil therein is always spaced below the top of the lowermost crankshaft bearing and, of course, well below the cylinder. But this places the oil in the sump beyond the reach of the moving engine parts within the crankcase and introduces the problem of feeding the oil to the cylinder wall and the crankshaft bearings. While a pump could be used for this purpose, the added expense entailed thereby practically rules it out as a solution to the problem.

It is, therefore, an object of this invention to provide a simple inexpensive device which has none of the disadvantages of a pump, but instead operates upon the time tested splash principle, for lubricating the moving parts inside the crankcase of an engine of the type having a vertically disposed crankshaft.

More specifically it is an object of this invention to provide a unitary oil slinger member rotatably mounted within the engine with a portion thereof dipping into the oil bath and driven from the engine timing gears so as to throw oil out of the sump and onto the moving engine parts during operation of the engine.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

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The accompanying drawings illustrate two complete examples of the physical embodiments of the invention constructed according to the best modes so far devised for the practical application of the principles thereof, and in which:

Figure 1 is an elevational view of a single cylinder gasoline engine embodying the lubricating device of this invention, a portion of the crankcase and oil sump being broken away to better illustrate the lubricating device itself;

Figure 2 is an enlarged sectional view of a portion of the engine, said view corresponding substantially to that portion of the engine in the area shown broken away in Figure 1;

Figure 3 is a bottom view of the oil slinger member per se;

Figure 4 is a side view of a horizontal engine of different design from that shown in Figure 1, illustrating the application of this invention thereto, parts of said view being broken away and in section and on the plane of the line 4—4 in Figure 5;

Figure 5 is a horizontal sectional view through Figure 4 on the plane of the line 5—5; and

Figure 6 is a detail sectional view taken through Figure 5 on the plane of the line 6—6.

Referring now more particularly to the accompanying drawings in which like numerals designate like parts throughout the several views, and especially to Sheet 1 thereof, the numeral 5 designates generally a small single cylinder internal combustion engine of the type having a cylinder 6 at one side of a crankcase 7, the axis of the cylinder being horizontal, and having a crankshaft 8 mounted on a vertical axis.

Inside the crankcase, as is conventional, are a number of moving parts which are in need of lubrication at all times during operation of the engine, including the lower crankshaft main bearing 9, the upper crankshaft bearing 10, the connecting rod bearing 11, as well as the cylinder wall and the wrist pin bearings (not shown). The crankshaft projects from the crankcase at both its upper and lower ends, its upper end portion having a starter pulley 12 secured thereto and its lower end portion 13 being connectible with a device to be driven by the motor.

The lower wall 14 of the crankcase has a boss 15 in which the lower main bearing 9 is press fitted and which carries an oil seal 16 beneath the bearing. An annular space 17 around the crankshaft, between the lower main bearing and the oil seal, is communicated with the interior of the crankcase through an upwardly opening well 18 in the boss. The slight head of oil which

accumulates in this well 18 and the space 17 is beneficial in easing the friction at the heavily loaded lower main bearing during starting and before a fresh supply of oil is brought to the bearing through its oil hole 19.

The supply of lubricating oil for the engine is held in a sump 20, formed as part of a substantially L-shaped shell 21 which is bolted to the crankcase by screws 22 and closes what would be the bottom of the crankcase in a vertical or upright engine. A gasket 25 between the crankcase and the sump shell seals the connection between the two; and a drain plug 26, at the bottom of the outer side wall of the sump, enables the oil to be drained therefrom.

Oil from the sump is thrown onto the moving engine parts inside the crankcase by means of the novel lubricating device of this invention, which in the Figure 1 embodiment comprises a unitary disc-like slinger member 27 and an intermediate gear 28, which drives the slinger member and is in turn driven by a gear 29 on the crankshaft. The gear 29 is just above the main bearing and may be one of the timing gears of the engine.

Both the oil slinger and the intermediate gear are best molded of plastic, preferably nylon. The slinger comprises a hub portion 30 having a bore 31 therethrough to provide a bearing by means of which the slinger may be mounted, a frusto-conical medial portion 32 having gear teeth 33 on its outer conical face, and a flat rim-like outer portion 34 having three paddle-like projections 35 thereon which dip into the oil in the sump and throw it onto the moving engine parts in the interior of the crankcase as the slinger rotates.

The slinger is freely rotatably mounted on a bearing structure, indicated generally by the numeral 36, which projects into the sump from a boss 37 on the side wall of the sump adjacent to the crankcase proper, with its axis disposed at an acute angle to the crankshaft axis so that the lower side of the slinger periphery is adjacent to the bottom of the sump, and the opposite side of its periphery is closer to the crankshaft. The gear teeth 33 are on the bottom face of the slinger, i. e., the surface which faces the crankshaft.

The intermediate gear 28, like the slinger member, has a bored hub 41, and is mounted on a vertical bearing structure, designated generally by the numeral 42, which projects up into the crankcase from a boss 43 on the bottom crankcase wall, between the crankshaft and the slinger, so that the driving gear has its axis parallel to that of the crankshaft and meshes with the gear 29 on the crankshaft and with the gear teeth 33 on the bottom of the slinger.

The bearing structures by which the intermediate gear and the slinger are mounted include bored plugs 44 which are press fitted into accurately bored apertures in the bosses 43 and 37 in the bottom crankcase wall and the inner sump wall, respectively. Each plug has a stub shaft 47 secured thereto by a screw 48, upon which the hubs of the slinger and gear are directly journalled, the thrust bearings being provided by the adjacent ends of the plugs and heads 48 on the stub shafts. The employment of the plugs 44 eliminates the necessity for facing operations on the crankcase and sump shell castings, and thus facilitates manufacture of those parts.

It will be seen that the orbit of the paddle-like projections on the underside of the slinger member is such that, as the slinger rotates, the projections dip into the oil in the sump, passing near to the bottom thereof so that the slinger will operate satisfactorily when the oil level in the sump is low, and then move upwardly toward the crankshaft, passing part way into the interior of the crankcase itself. In the course of this orbit the projections throw oil onto the moving parts in the interior of the crankcase between and including the lower and upper crankshaft bearings 9 and 10, respectively, distributing oil substantially uniformly over all of them. After circulating over the parts, the oil of course returns to the sump by gravity.

The modified embodiment of the invention illustrated in Figures 4, 5 and 6 differs from that described principally in the way in which the sump for the lubricating oil is provided and the way in which the slinger is driven. Thus, the oil sump instead of being provided by an L-shaped shell bolted to what normally is the bottom of the crankcase is formed by a cover plate 49 bolted to and closing what, in a vertical engine, is the side of the crankcase.

This cover plate 49 not only provides the base 50 by which the engine is mounted in a horizontal position with its crankshaft axis vertical, but also has the lower main crankshaft bearing 51 and one of the cam shaft bearings 52 therein. To preclude the drainage of lubricant from the oil reservoir provided by the interior of the cover plate 49 the bearings 51 and 52 are located in upstanding bosses 53 and 54, respectively, the tops of which are well above the normal oil level.

The slinger 55 by which the oil is lifted from the sump or reservoir and thrown upwardly against the moving engine parts, as in the previously described embodiment of the invention, is mounted to rotate about an inclined axis so as to facilitate geared driving connection between the slinger and one of the timing gears 56, the bottom of the slinger being provided with gear teeth 57 for this purpose.

Attention is directed to the fact that no intermediate gear is necessary in this embodiment of the invention. The specific construction of the mounting for the slinger is also slightly different in this form of the invention and consists merely of a tubular stub shaft 58 bolted to an upstanding boss 59 which forms an integral part of the cover plate 49 and on which the slinger is freely journalled.

From the foregoing description taken in connection with the accompanying drawings, it will be readily apparent to those skilled in this art that this invention provides a simple inexpensive means of reliably lubricating the moving parts of a small gasoline engine which, because of its being mounted with its crankshaft axis vertical cannot employ the customary splash system of oiling wherein the crankshaft itself or some means on the connecting rod dips down into the oil bath to throw the oil up onto the moving parts; and that it entirely eliminates the problem of loss of lubricant through the bottom main bearing of such horizontal engines.

What I claim as my invention is:

1. In an internal combustion engine having a vertical crankshaft journalled in axially aligned top and bottom bearings, a crankcase and a horizontal cylinder at one side of the crankshaft: means defining an oil sump in open communication with the interior of the crankcase and hav-

ing a portion thereof near the bottom bearing of the crankshaft; a rotatable oil slinger; means rotatably mounting the slinger with its axis disposed at an acute angle to an axis parallel to that of the crankshaft and with part of the slinger disposed in that portion of the oil sump near the bottom bearing and extending beneath the normal oil level; and a geared driving connection between the crankshaft and said rotatable slinger, so that the slinger rotates during operation of the engine and acts to throw oil from the sump upwardly into the crankcase interior to lubricate the moving engine parts therein.

2. In an internal combustion engine having a vertical crankshaft, a crankcase, axially aligned top and bottom bearings in which the crankshaft is journalled, and a horizontal cylinder at one side of the crankshaft: means defining an oil sump in open communication with the interior of the crankcase, said oil sump having its bottom on a level below that of the bottom bearing; a rotatable oil slinger; means rotatably mounting said oil slinger with its axis disposed at an acute angle to an axis parallel to that of the crankshaft and at that side of the crankshaft opposite the cylinder and with the lower portion of the slinger contiguous to the bottom of the oil sump so as to dip down into the oil contained therein, the angular disposition of the slinger positioning the same so that the oil flung upwardly thereby as the slinger rotates is thrown up into the interior of the crankcase and against the moving engine parts therein; and a driving connection between the crankshaft and said rotatable slinger through which the slinger is rotated during operation of the engine.

3. In an internal combustion engine, the structure set forth in claim 2 further characterized by the fact that the driving connection between the crankshaft and the slinger comprises one of the timing gears of the engine, and gear teeth on the underside of the slinger meshing with said timing gear.

4. In an internal combustion engine of the horizontal type having a crankshaft and a cam shaft rotating on vertical axes, top and bottom bearings in which the crankshaft and cam shaft are journalled, a crankcase and a horizontally disposed cylinder at one side of the crankshaft: a removable pan-like cover plate closing the bottom of the crankcase and defining an oil sump in open communication with the interior of the crankcase; upstanding bosses rising from the bottom of said cover plate in which the lower bearings for the crankshaft and cam shaft are mounted, the top of said bosses being a substantial distance above the bottom of said sump so as to be above the normal oil level; timing gears on the crankshaft and cam shaft directly above the tops of said bosses; a rotatable oil slinger; means rotatably mounting the slinger with its axis at an angle to the axis of one of said shafts and at the side thereof opposite the cylinder and with the lower portion of the rotatable slinger contiguous to the bottom of the oil sump and its upper portion contiguous to the timing gear on said shaft; and gear teeth on the slinger meshing with said timing gear so that during operation of the engine the slinger rotates to lift oil from the sump and throw it upwardly into the interior of the crankcase.

5. In an internal combustion engine having a vertical crankshaft, a crankcase and a horizontal cylinder at one side of the crankcase: means defining an oil sump in open communication with the interior of the crankcase, said oil sump having its bottom spaced a substantial distance below the cylinder; a rotatable oil slinger having a plurality of vane-like projections thereon; means rotatably mounting said oil slinger at the side of the crankshaft opposite the cylinder with the axis of the slinger disposed at an acute angle to that of the crankshaft and with one side of the orbit of said projections adjacent to the bottom of the sump and the opposite side of said orbit closer to the axis of the crankshaft and projecting partway into the crankcase and pointing towards the cylinder so that upon rotation of the slinger oil is thrown from the sump into the crankcase interior toward the cylinder to lubricate the moving engine parts therein; and a driving connection between the slinger and the crankshaft.

6. In an internal combustion engine of the type having a crankcase, a crankshaft rotatable on a vertical axis in main bearings mounted in the walls of the crankcase, and an oil seal between the crankcase and the crankshaft beneath the lowermost main bearing to prevent leakage of oil out of the interior of the crankcase: means defining an oil sump at one side of the crankcase in open communication with the interior of the crankcase and having its bottom below the level of said oil seal, so that oil tends to drain from the crankcase into said sump, thereby preventing oil leakage out of the crankcase when the engine is idle; a disc-like rotatable oil slinger having a plurality of paddle-like projections spaced from its axis; means rotatably mounting said oil slinger with its axis disposed at an acute angle to that of the crankshaft and with one side of the orbit of said projections adjacent to the bottom of said sump and the opposite side of said orbit closer to the axis of the crankshaft; gear teeth on the surface of said oil slinger which faces the crankshaft; and a gear rotatably driven by the crankshaft and meshing with the gear teeth on said oil slinger to rotate the slinger during operation of the engine and thus cause the projections thereon to throw oil from the sump into the crankcase interior to lubricate the moving parts therein.

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Nov. 9, 1954 L. J. LECHTENBERG 2,693,789

AIR-COOLED INTERNAL-COMBUSTION ENGINE

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Fig. 1.

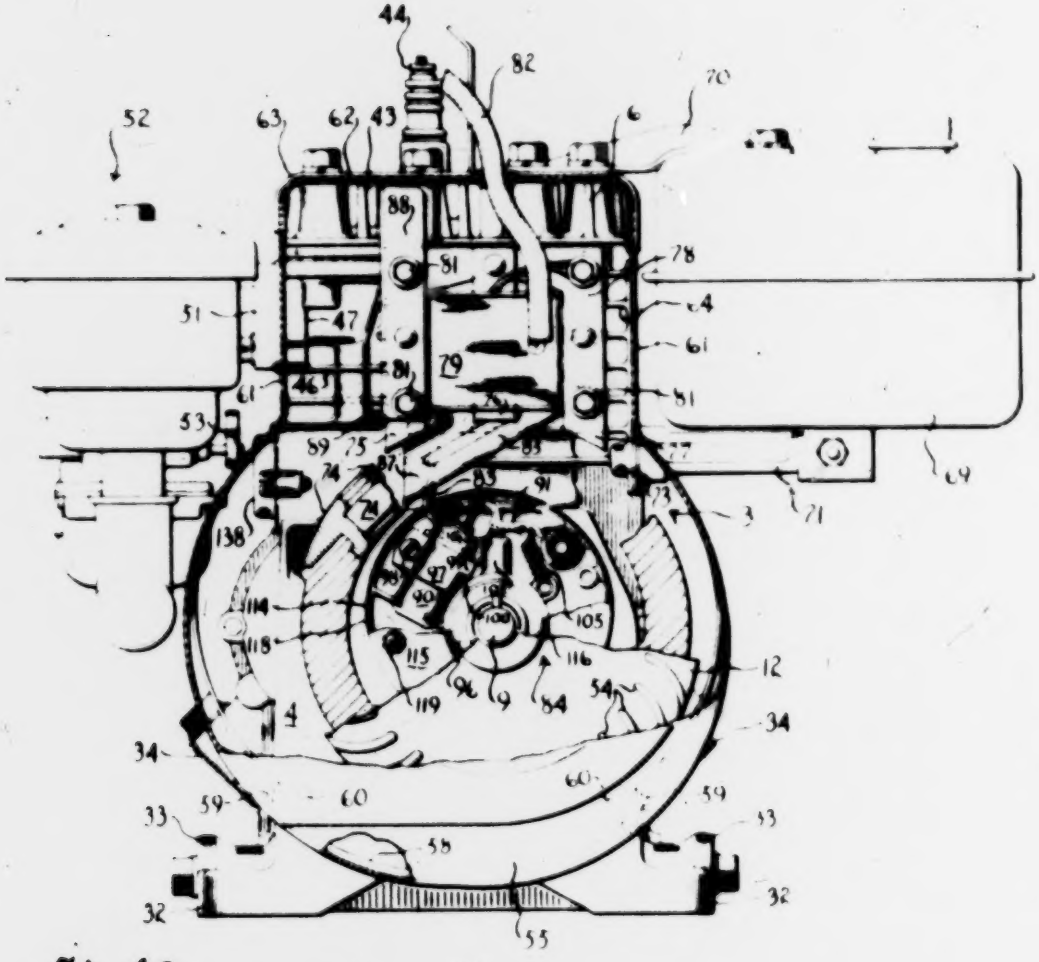
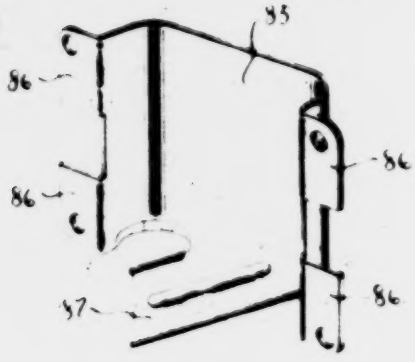


Fig. 1a.



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

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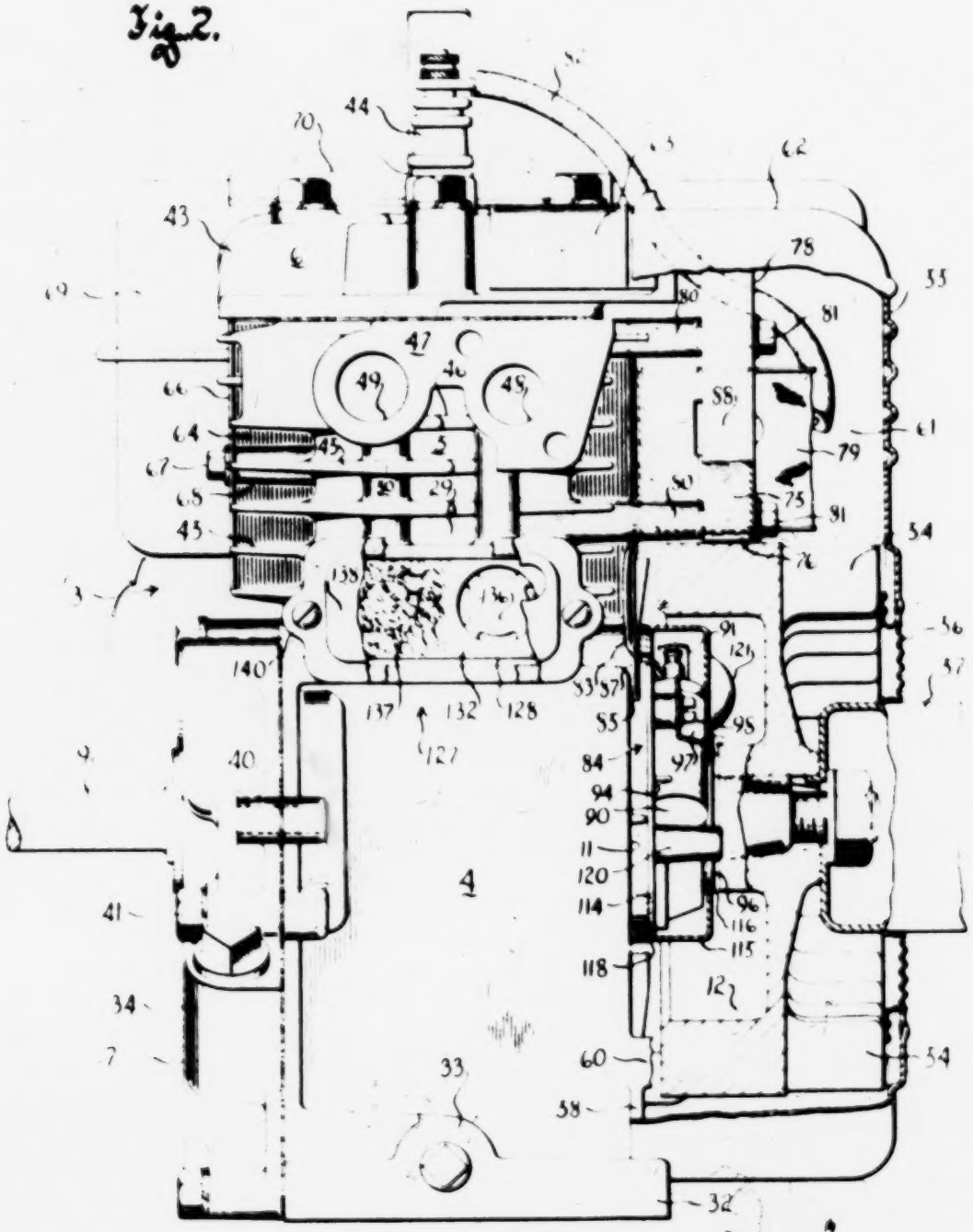
Fig. 2.



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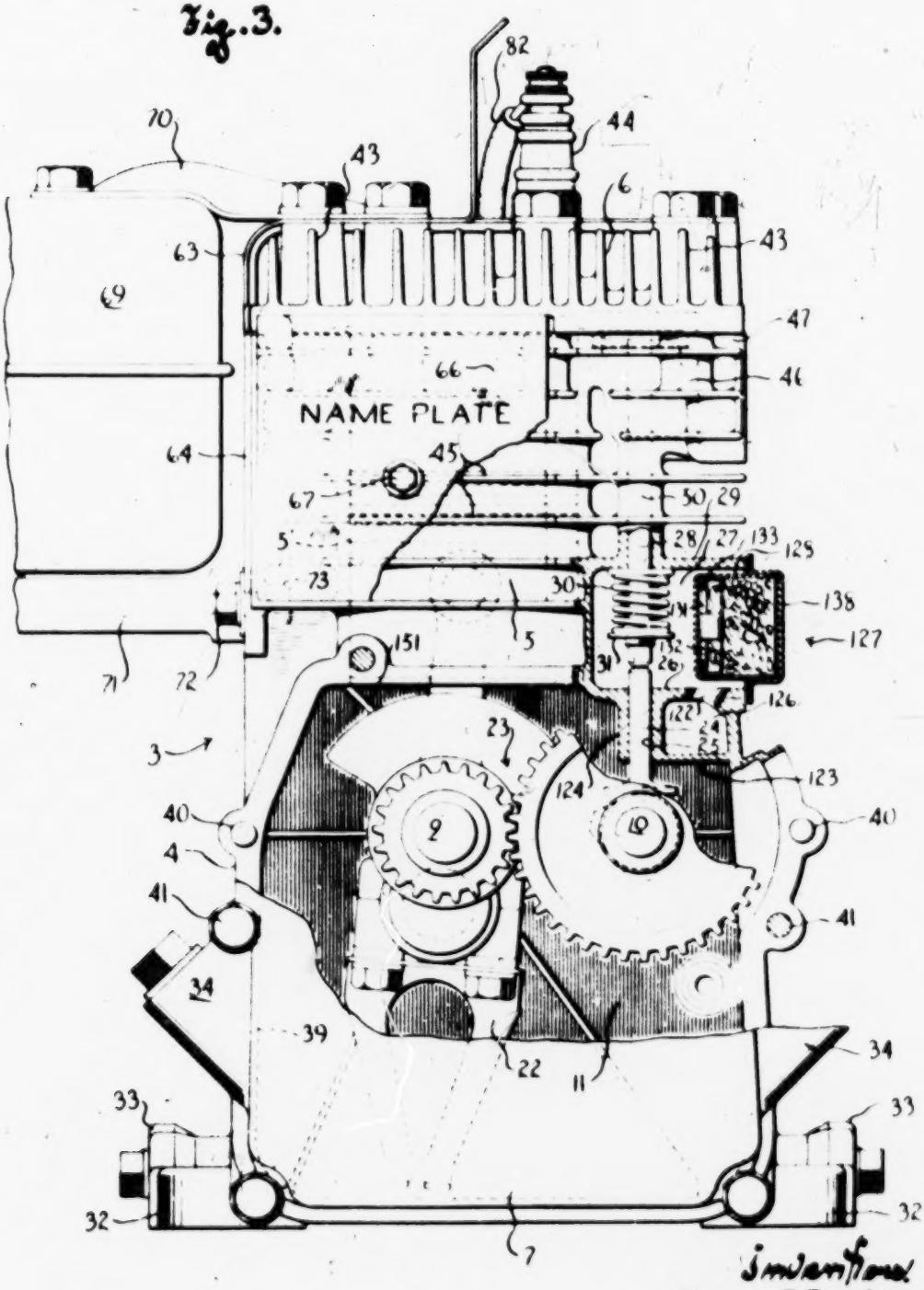
AIR-COOLED INTERNAL-COMBUSTION ENGINE

Filed May 11, 1953 9 Sheets-Sheet 3

Fig. 3.



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

Filed May 11, 1953 9 Sheets-Sheet 4

Fig. 4.

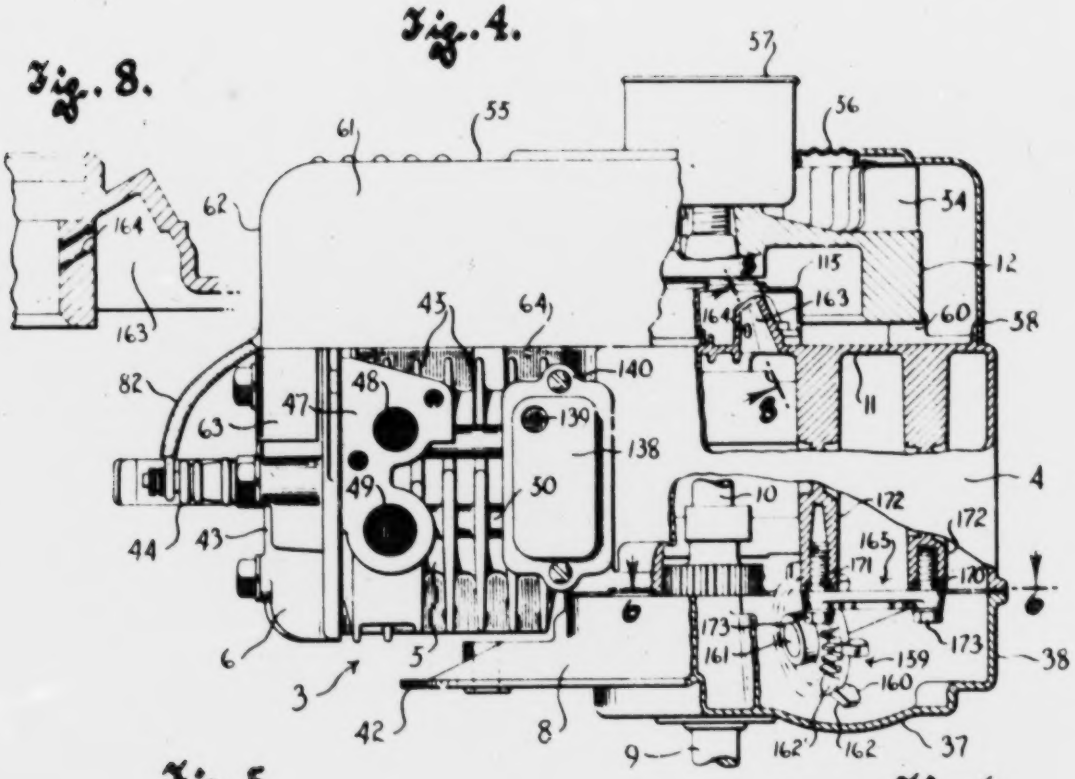


Fig. 8.

Fig. 5.

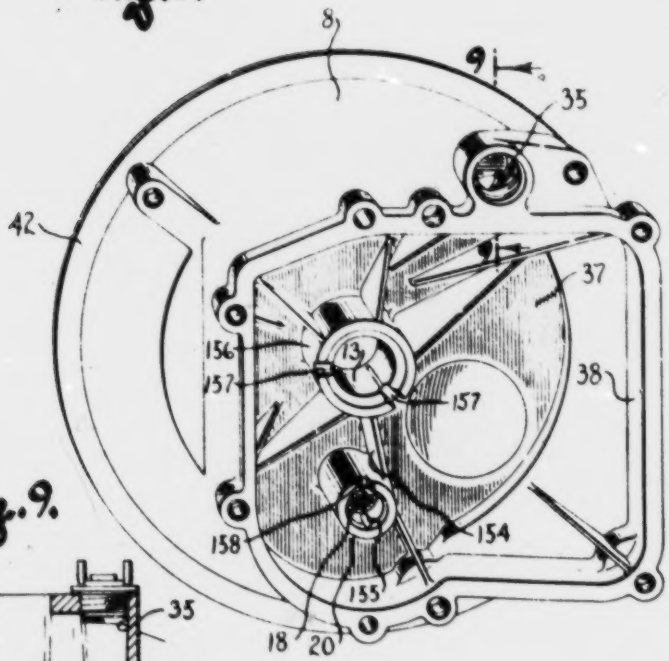


Fig. 6.

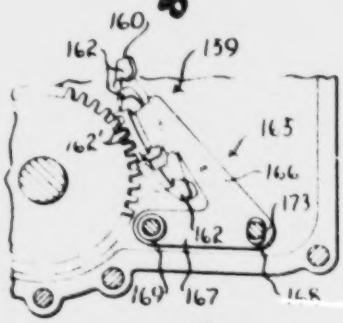


Fig. 7.

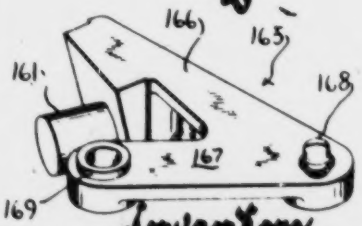
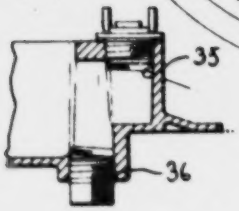


Fig. 9.



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

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Fig. 12.

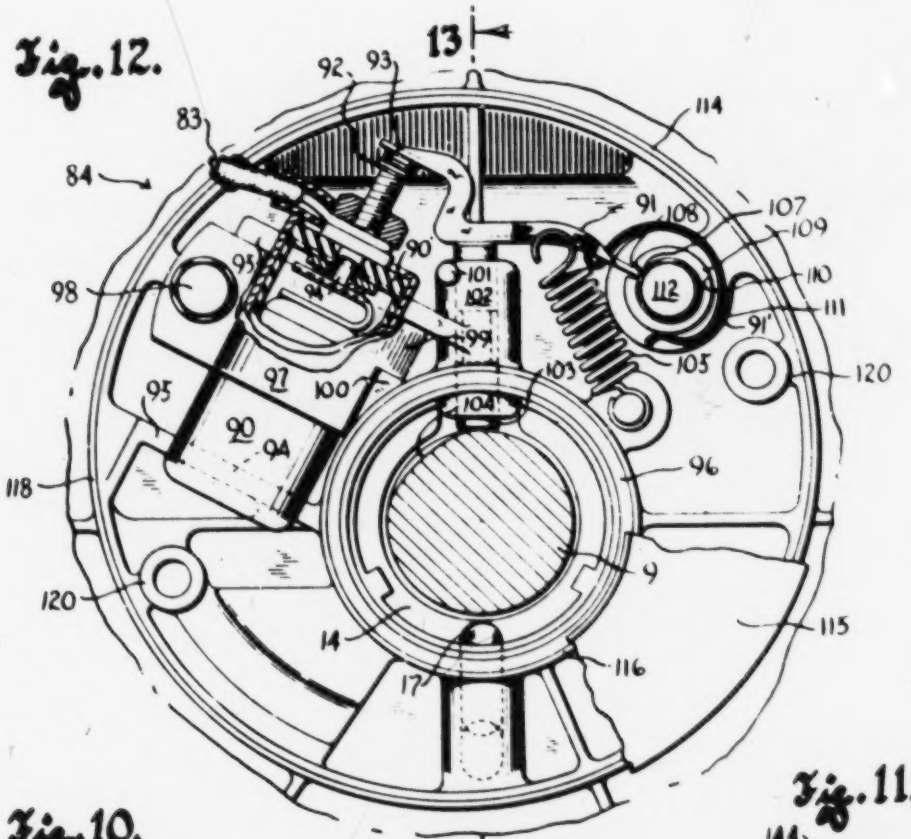


Fig. 10.

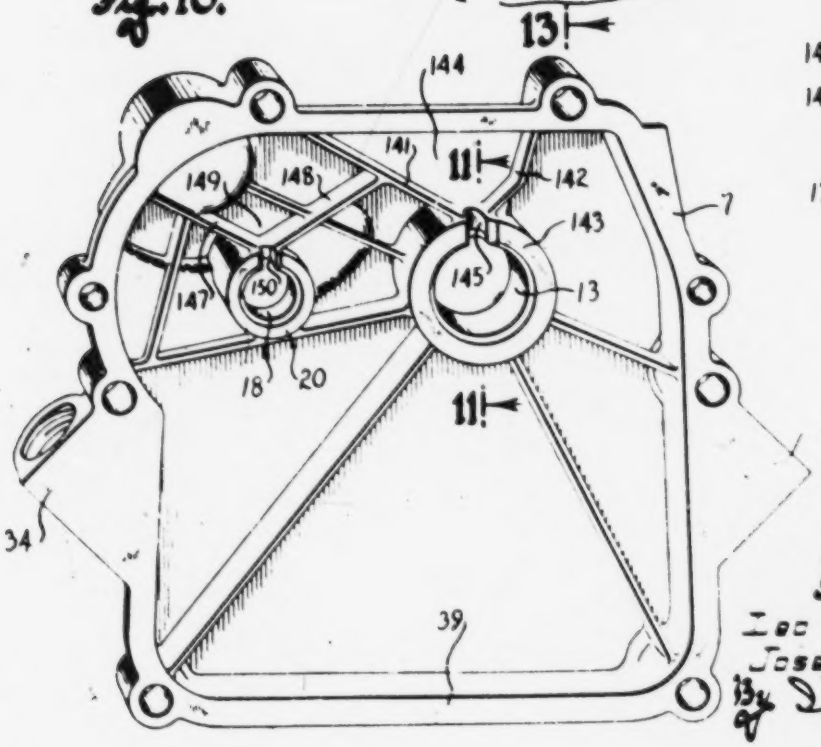
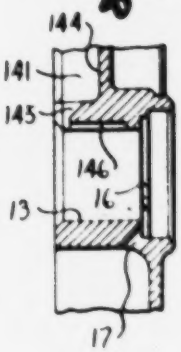


Fig. 11.



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

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Fig. 15.

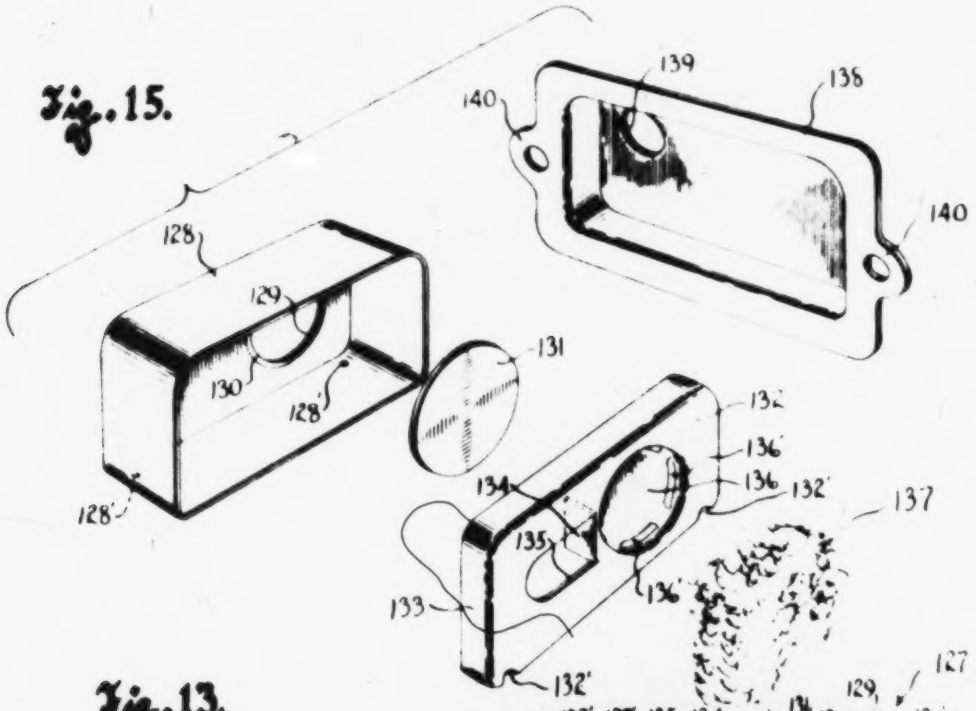


Fig. 13.

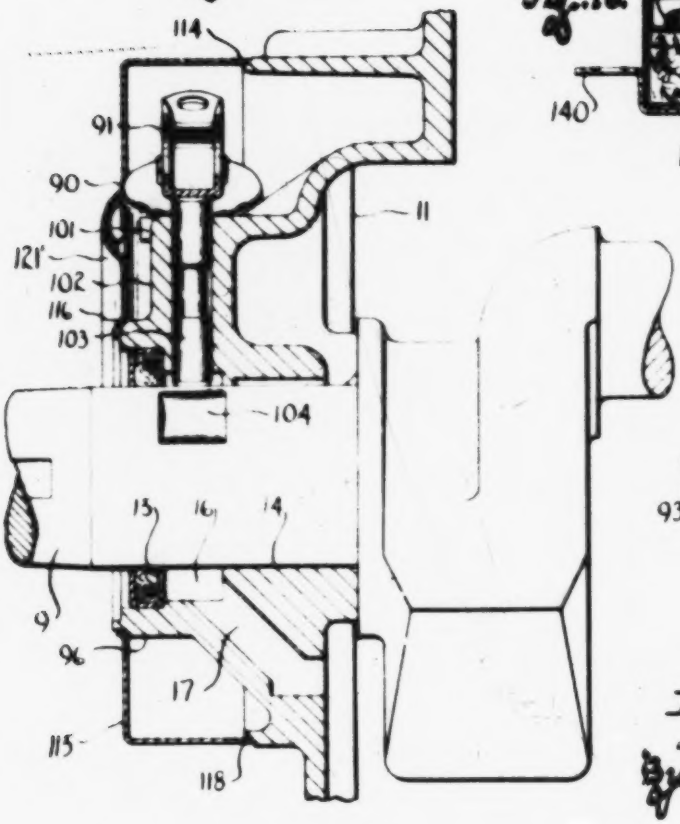


Fig. 16.

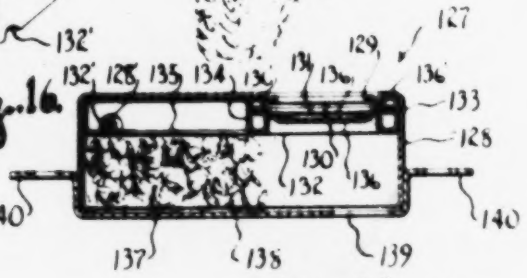
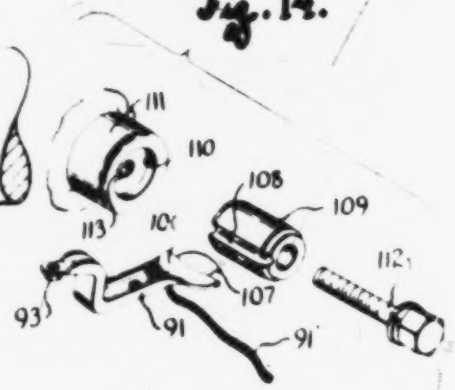


Fig. 14.



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Nov. 9, 1954 L. J. LECHTENBERG 2,693,789

AIR-COOLED INTERNAL-COMBUSTION ENGINE

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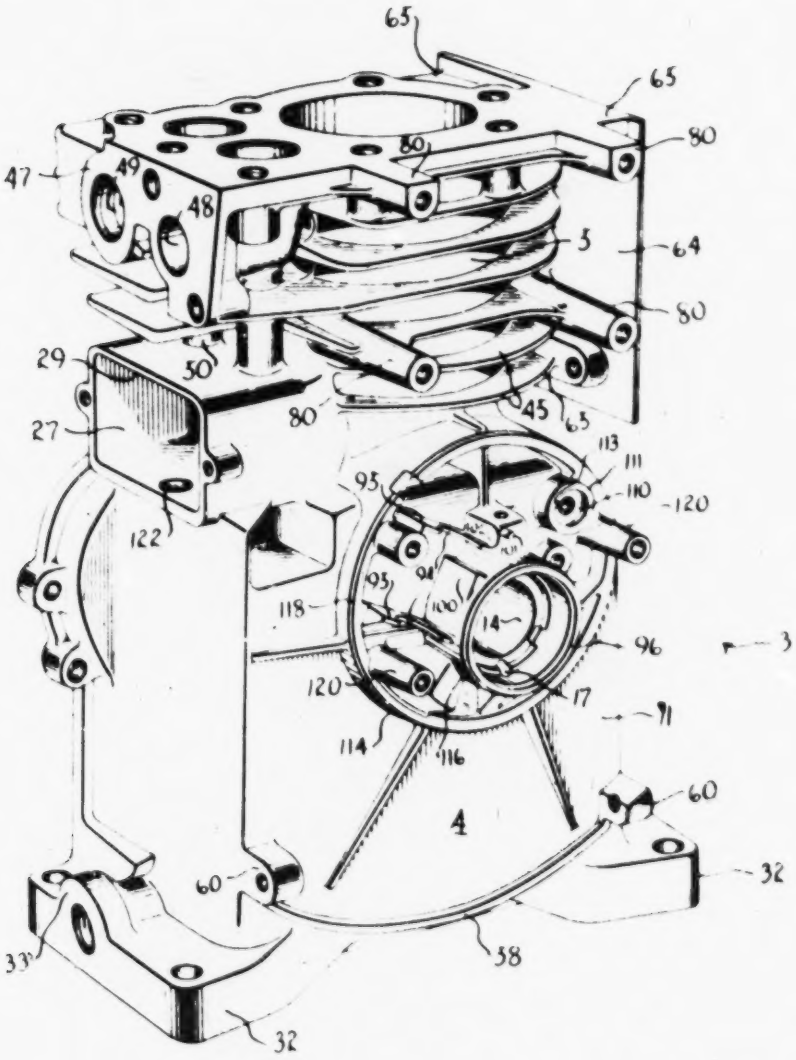
Fig. 17.



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

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Fig. 20.

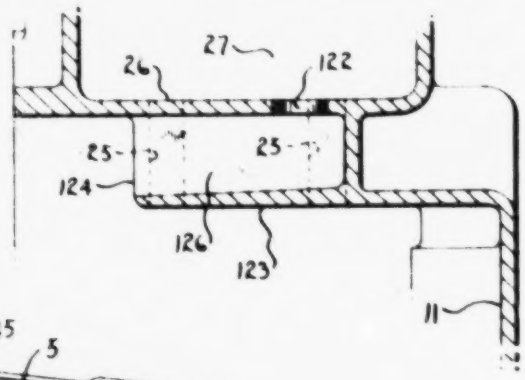


Fig. 18.

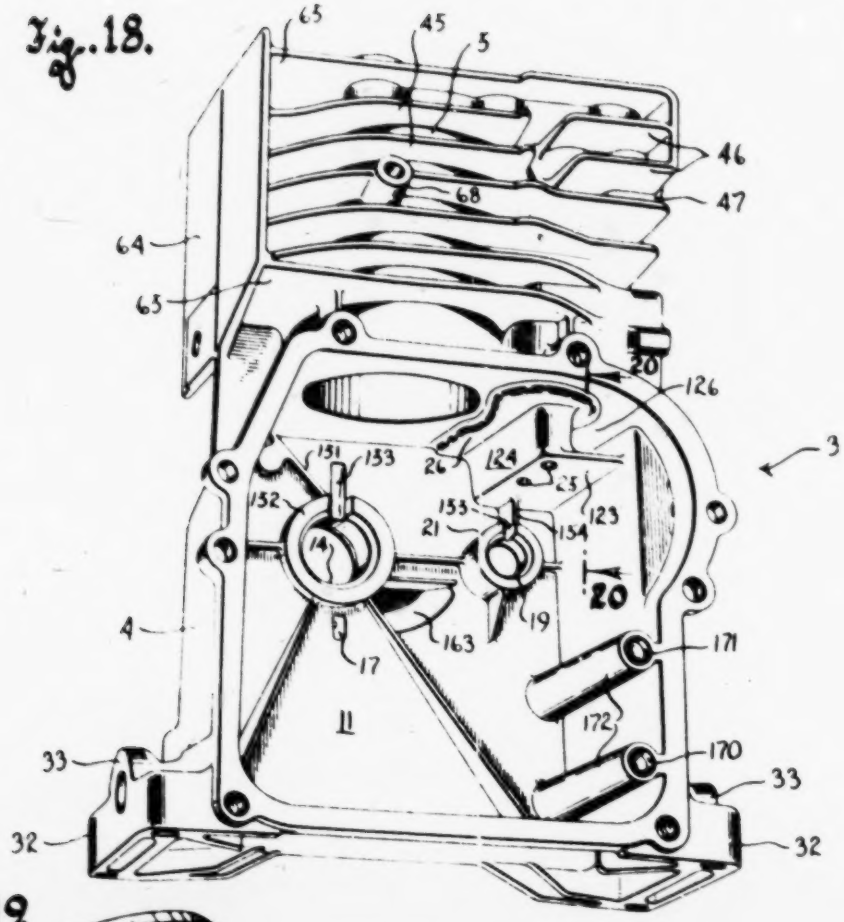
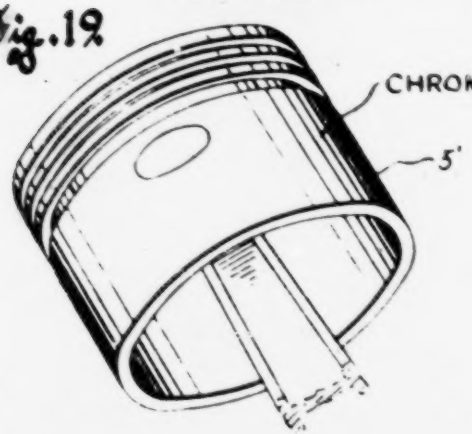


Fig. 19



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AIR-COOLED INTERNAL-COMBUSTION ENGINE

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Fig. 21.

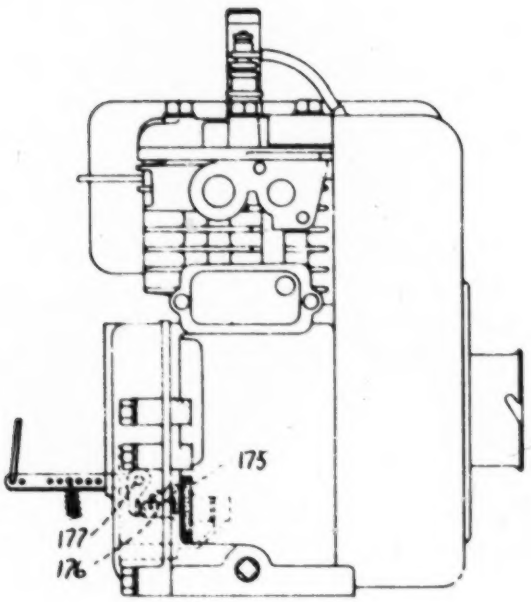


Fig. 22.

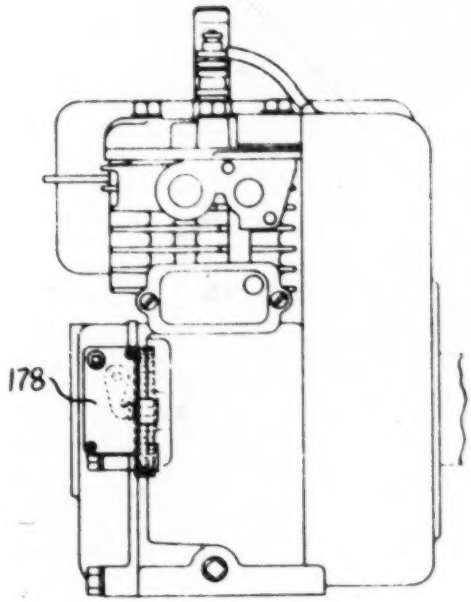
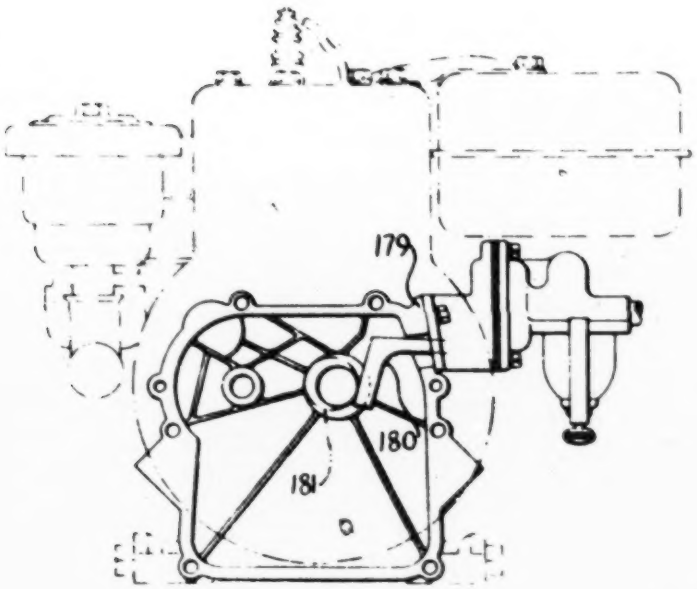


Fig. 23.



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United States Patent Office

2,693,789

Patented Nov. 9, 1954

2,693,789

AIR-COOLED INTERNAL-COMBUSTION ENGINE

Leo J Lechtenberg, Milwaukee, Wis., assignor to Briggs & Stratton Corporation, Milwaukee, Wis., a corporation of Delaware

Application May 11, 1953, Serial No. 354,056

16 Claims. (Cl. 123—195)

This invention relates to internal combustion engines and refers more particularly to single cylinder, air cooled, four-stroke cycle engines of the type widely used on power lawn mowers and many other well-known appliances.

Manufacturers of such engines are constantly being beseached by producers of power lawn mowers and other portable appliances and equipment to reduce the weight and price of their engines. The entire engine industry is thus well aware of the urgent demand made upon it to produce a lighter, less expensive engine but, of course, the attainment of this o[illegible]tive may not be at a sacrifice of power output, reliabili[illegible] ruggedness.

The underlying and motivating objective of this invention thus is to produce an engine which delivers more horsepower per dollar of cost and pound of weight than has heretofore been achieved.

Cost reduction obviously can be attained by simplification of the engine and by reducing the number of component parts requiring assembly. With a view toward taking full advantage of this expedient, the present invention has as its purpose to provide an internal combustion engine of the character described wherein many of the individual component parts of engines as they had been built before are an integral part of either one of two main castings which together with the cylinder head comprise the body of the engine.

More specifically, it is the purpose of this invention to provide an engine wherein a single main casting, which may be either a die casting or a sand casting, provides not only the cylinder with its encircling heat dissipating fins, and all but one wall of the crankcase, but in addition has many of the parts which heretofore were assembled as separate units as, for instance, air directing walls, oil deflecting baffles and the like, incorporated in the casting as an integral part thereof. Since the greatest economy is effected by die casting the main parts of the engine body, this form of casting is preferred over the sand casting method. Nevertheless, it will be understood that either casting method may be followed so that where the term "die casting" is used hereinafter it is not intended to rule out sand casting.

One of the features of the invention resides in the provision of an air directing wall or baffle formed as an integral part of the cylinder-crankcase casting tangentially to all of the fins on the cylinder so that a portion of the die in which this wall is cast may be used as a large capacity gate through which the molten metal may be quickly passed into the cylinder-forming part of the die. This assures the desired metal density in the cylinder walls where casting defects would be most serious.

In keeping with the overall objective of reducing the cost of the engine and simplifying its assembly, it is another object of this invention to use the metal name plate with which engines have always been equipped to form part of the air directing means, and to this end the name plate is fastened to the side of the cylinder with one edge thereof contiguous to the baffle which is cast integral with the cylinder and extends across an adjacent side of the cylinder.

Another very important way in which the cost of the engine can be reduced is by so designing and constructing the engine that it may be adapted to a wide variety of uses with a minimum amount of change in its construction.

Heretofore the ordinary single cylinder, internal

combustion engine was so designed that to adapt the same to different uses often entailed an entirely new cylinder-crankcase casting. This would rule out die casting and the obvious savings effected thereby since the cost of the dies involved would be prohibitive. By contrast, the engine of this invention is so designed that it may be adapted to a wide variety of uses without in anywise changing the cylinder-crankcase casting. Only the cover of the crankcase need be changed, and since the dies involved in the production of the cover castings are by no means as complicated and expensive as those required for the cylinder-crankcase casting, even die casting the cover units is feasible, and for shorter runs where the cost of tooling up is not warranted, sand castings may be employed for the covers.

To illustrate how easily the engine of this invention may be adapted to different uses, it might be noted that the adaptation of an engine intended for ordinary general utility with the engine operating in an upright fashion, that is with its cylinder vertical, to horizontal operation as in rotary type lawn mowers, merely requires the simple substitution of one cover casting for another. By the same token the engine can be adapted to many different types of horizontal and vertical mountings, and to various special uses, as will be hereinafter more fully described.

Since lubrication of an engine operating with its cylinder horizontal presents problems not encountered when the engine is operating in a vertical position, the side of the engine which is lowermost (in the horizontal position of the engine) must be constructed to provide an oil sump and since changes in the cylinder-crankcase casting are to be avoided, this side of the engine is formed by the crankcase cover, which as noted before, may be designed to satisfy any requirement. Also, means must be provided to lift the oil from the sump to the bearings in which the crankshaft and cam shaft turn. While this can, of course, be done by a pump, in the interests of economy it is desirable to avoid the use of a pump, and accordingly this invention employs the oil slinger which forms the subject matter of the pending application Serial No. 296,393, filed June 30, 1952, now Patent No. 2,669,322.

With a view toward simplifying the assembly of the slinger and assuring more efficient operation thereof, this invention has as another of its objects to provide a simple mounting bracket for the slinger which may be quickly secured to a wall of the crankcase and automatically located, during its securement, in a predetermined position which will assure the proper location of the oil slinger, both with respect to the bearings it serves and the timing gear which drives it.

Another object of this invention is to provide added assurance against oil leakage from the crankcase through the necessary breather opening, and in this connection it is a further object of the invention to afford such assurance by the simple expedient of a properly placed baffle cast integral with the crankcase.

With a view toward improving the air breather for the crankcase it is another object of this invention to vent the crankcase through a pocket or compartment in which the valve springs are located and with which the tappet openings communicate, and to control the flow of air to and from this valve spring pocket or compartment by means of a novel breather valve assembly formed as a cover for the valve spring compartment.

Again with a view toward achieving utmost simplicity and reducing assembly time to a minimum, this invention has as another of its objects to provide an improved manner of mounting the elements of the magneto ignition system upon the engine.

In this connection it is another object of this invention to provide a simple stamped sheet metal heat shield between the cylinder and the ignition coil which is clamped in place by the attachment of the coil armature to the side of the crankcase with a part thereof arranged to protect the lead to the breaker mechanism from contact with the flywheel.

Still another object of this invention is to provide a novel breaker mechanism wherein the stationary contact is mounted on one end of the condenser to thereby obviate

the need for providing a special insulated mounting for the stationary contact and at the same time enable the condenser mounting to be used for adjustment of the breaker point spacing.

In this connection it is a still further object of the invention to achieve simplicity and low cost by casting mounting means for the condenser and the breaker mechanism integrally with the crankcase casting.

Still another object of this invention is to provide a simple stamped sheet metal dust cover for the breaker mechanism which is held in place by two screws and upon being secured in place automatically coacts with portions of the casting wall upon which it is mounted to effect a tight fit.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is an end view of the engine of this invention viewing the same from the flywheel end of its crankshaft, parts of said view being broken away to show structural details;

Figure 1A is a perspective view of the heat shield located between the ignition coil and the adjacent side of the cylinder;

Figure 2 is a side view of the engine shown in Figure 1 with parts thereof broken away and in section and with the carburetor removed for clarity;

Figure 3 is a view of the power take-off end of the engine, with a substantial part of the crankcase cover broken away and parts of the cylinder-crankcase casting broken away and shown in section;

Figure 4 is a side view of the engine adapted for horizontal operation, that is, with its cylinder horizontal and showing the same equipped with a crankcase cover especially designed to adapt the engine for use as the power unit of a rotary type lawn mower, parts of said view being broken away and shown in section to better illustrate structural details;

Figure 5 is a perspective view of the crankcase cover casting by which the engine is adapted for use with its cylinder horizontal;

Figure 6 is a fragmentary detail sectional view taken through Figure 4 on the plane of the line 6—6 and illustrating particularly the manner in which the oil slinger is mounted;

Figure 7 is a perspective view of the mounting bracket for the oil slinger;

Figure 8 is a fragmentary detail sectional view through Figure 4 on the plane of the line 8—8 and illustrating the pocket in the upper wall of the crankcase into which oil is thrown by the slinger to feed the upper crankshaft bearing;

Figure 9 is a fragmentary detail sectional view through Figure 5 on the plane of the line 9—9 and illustrating the oil filler and drain ports;

Figure 10 is a perspective view of the crankcase cover used when the engine is intended for general utility with the cylinder in a vertical position;

Figure 11 is a fragmentary detail sectional view through Figure 10 on the plane of the line 11—11;

Figure 12 is a sectional view through the flywheel end of the crankshaft illustrating the magneto assembly of the engine, the major portion of the cover therefor being broken away;

Figure 13 is a detail sectional view through Figure 12 on the plane of the line 13—13, but to better illustrate the manner in which the breaker mechanism of the magneto is operated this view showes the crankshaft turned 90 degrees from the position in which it is shown in Figure 12;

Figure 14 is a perspective view of the breaker arm and the mounting therefor illustrating the parts disassembled;

Figure 15 is an exploded perspective view of the air breather assembly through which the crankcase interior is vented;

Figure 16 is a longitudinal sectional view through the air breather assembly;

Figure 17 is a perspective view of the crankcase-cylinder casting viewing the same from the side thereof at which the magneto is located;

Figure 18 is a perspective view of the cylinder-crankcase casting from the other side and looking into the interior of the crankcase;

Figure 19 is a perspective view of the piston;

Figure 20 is a detail sectional view through Figure 18 on the plane of the line 20—20;

Figure 21 is a side view of the engine illustrating the manner in which a mechanical governor may be applied to the engine in lieu of the air vane governor ordinarily used, without in anywise affecting the crankcase-cylinder casting;

Figure 22 is a side view of the engine showing the application of an externally located breaker mechanism, also without need for altering the crankcase-cylinder casting; and

Figure 23 is a view looking into the crankcase cover with the outline of the engine illustrated in broken lines and showing the manner in which a fuel pump may be added and operated without altering the crankcase-cylinder casting.

Referring now particularly to the accompanying drawings in which like numerals indicate like parts throughout the several views, the numeral 3 designates generally the crankcase-cylinder casting of the engine, consisting of a crankcase portion 4 and a cylinder 5. This main casting together with a cylinder head 6 and a crankcase cover casting 7 or 8 (depending upon the intended use of the engine) comprises the entire body of the engine. For ordinary general utility where an upright disposition of the engine is desirable, the crankcase cover 7 is used, but where the engine is intended to operate with its cylinder axis horizontal as in the driving units of rotary type lawn mowers, the cover 8 is used. These covers are best illustrated respectively in Figures 10 and 5.

The bearings for the engine crankshaft 9 and its cam shaft 10 are mounted in the cover casting and the end wall 11 of the crankcase-cylinder casting opposite the cover, and to enable adapting the engine to any one of a wide variety of uses without need for changing the crankcase-cylinder casting the flywheel 12 is mounted upon the end of the crankshaft which protrudes from the casting wall 11 and the opposite power take-off end of the crankshaft protrudes from the cover casting regardless of which of the two types of covers is employed.

The crankcase-cylinder casting 3, the cylinder head 6 and the crankcase cover 7—8 are cast of aluminum alloy, preferably as die castings, and the crankshaft and cam shaft run directly in bearings bored in the cover casting and the opposite wall of the crankcase-cylinder casting. In other words, the bearings are not bushed, but can be bored out to receive bushings (not shown) after the engine has been in service long enough to cause serious bearing wear.

The crankshaft bearings 13 and 14 are each equipped with an oil seal 15 mounted in a counterbore at the outer end of the bearing to prevent loss of oil from the crankcase, and each of these bearings has an annular oil collecting chamber 16 inwardly of its oil seal to receive the oil which flows outwardly along the shaft. Oil which accumulates in these collecting chambers is returned to the crankcase interior by passages 17.

The cam shaft bearings 18 and 19 formed respectively in the crankcase cover and the opposite wall 11 are likewise bushingless, but as distinguished from the crankshaft bearings do not extend through the crankcase walls. Instead these cam shaft bearings are formed by wells closed at the bottom and provided largely by bosses 20 and 21, respectively, projecting inwardly from the casting walls.

The crankshaft is of conventional construction but the piston 5' though of conventional design and cast of aluminum alloy is distinguished by the fact that it is plated with chromium or some other suitably hard wearing metal. By this expedient it is possible to have both the cylinder and the piston formed of the same basic die casting metal without incurring the cost of lining or plating the cylinder wall, for contrary to previous belief, it has been conclusively demonstrated that the piston rings will not unduly wear a naked, unprotected aluminum alloy cylinder wall. The saving thus effected is substantial since to plate the

piston costs but a fraction of what it costs to either plate or line the cylinder wall.

The cam shaft 10, which is of conventional construction is driven from the crankshaft by the usual set of timing gears 23 which are located adjacent to the crankcase cover, and when the engine is intended for general utility, the connecting rod has an oil splashing dipper 22 secured thereto to effectively splash the oil contained in the crankcase up into all parts of the crankcase interior and into the cylinder.

Valve tappets 24 operated by the cam shaft are slidably received in relatively long holes 25 drilled through a wall 26 of the crankcase-cylinder casting. The outer ends of these holes open to a valve spring pocket or compartment 27 in which the tappets abut the valve stems 28 to lift the valves in the customary manner. The valve stems enter the compartment 27 through its top wall 29 and the valve springs 30 are confined between this top wall 29 and spring seats 31 on the lower ends of the valve stems.

The valve spring pocket or compartment 27 not only affords a convenient enclosure for the valve springs but, as will be hereinafter more fully described, forms part of the means by which the crankcase interior is ventilated.

If the engine is intended for operation with its cylinder vertical the crankcase-cylinder casting 3 is provided with integral mounting feet 32 and bosses 33 at opposite sides of the casting, either one of which may be drilled and tapped to provide an oil drain port. But when the engine is intended for operation with its cylinder axis horizontal, the feet and drain port are not needed and hence those portions of the die or mold in which the feet and bosses 33 are formed would be blocked off. Also, when the engine is intended for general utility and the cover 7 is employed the oil filler port may be located at either side of the engine, and to provide for such alternate location the cover casting 7 has a pair of bosses 34 either of which may be drilled and tapped to provide the oil inlet port.

If the engine is intended for operation with its cylinder horizontal and the other cover casting 8 is used both the oil inlet port 35 and the oil drain port 36 are in the cover casting as best shown in Figures 5 and 9. These two ports are disposed in parallel juxtaposition, one extending down from the top of the cover casting and the other extending up from the bottom thereof so that in drilling out the ports they are communicated with one another and with the interior of the cover which has a relatively deep dish-shaped formation with a bottom wall 37 and side walls 38 extending upwardly therefrom. The gasket face formed by the outer edges of the side walls 38 has the same shape as the gasket face formed by the edges of the side walls 39 of the cover casting 7 so as to interchangeably fit the open side of the crankcase. Regardless of which cover is employed it is accurately located by dowel pins 40 and secured in place by screws 41.

If the engine is intended for use as the power unit of a rotary type lawn mower the cover casting 8 has a mounting flange 42 cast integrally therewith. This flange seats upon and is secured to the deck of the lawn mower (not shown) to firmly mount the engine with the power take-off end of its crankshaft extending down below the deck.

The cylinder head 6 is of conventional construction with cooling fins 43 cast integrally therewith, and has the usual spark plug 44 mounted therein. The cylinder cooling fins 45 are cast integrally with and encircle the cylinder 5, and cooling fins 46 are cast integrally with a boss-like portion 47 of the crankcase-cylinder casting in which the intake port 48 and the exhaust port 49 are located, the fins 46 being in line with the adjacent cylinder cooling fins 45. Below the boss-like portion 47 the cylinder fins 45 are extended to also embrace the portion 50 of the crankcase-cylinder casting in which the stem 28 of the exhaust valve slides.

The boss-like portion 47 provides a flat face against which an attaching flange 51 of the carburetor indicated generally by the numeral 52 is bolted. The carburetor with its air cleaner is one complete fully assembled unit, the placement of which on the engine requires no more than the fastening of the flange 51, the connection of the gas line and the connection of a driving link (not shown) between the customary air vane governor and the throttle valve crank 53.

The flywheel 12 is equipped with the customary fan blades 54 which induce a flow of cooling air into the inlet of a shroud 55 and from the outlet thereof against the adjacent side of the cylinder. The inlet of the shroud is protected by the customary rotary screen 56 which is preferably mounted upon a rope starter pulley 57 suitably secured to the adjacent end of the crankshaft.

The inner portion of the shroud 55 is substantially cylindrical and snugly fits the underside of a correspondingly shaped ridge 58 with the adjacent edge of the shroud lying flat against the face of the casting wall 11. The shroud is held in this position by screws 59 threaded into bosses 60 on the casting. The upper portion of the shroud has substantially flat opposite side walls 61 connected by a top wall 62. The edge of this top wall is contiguous to a separate sheet metal cylinder head cover 63 disposed across the top of the cylinder head fins to direct part of the air issuing from the shroud across the top of the cylinder head between the cooling fins thereon.

At the side of the engine opposite the carburetor is a thin flat wall 64. This wall serves several purposes. It is cast integrally with the crankcase-cylinder casting and is tangentially contiguous to and joins with all of the cylinder cooling fins 45 extending laterally to opposite sides of the median plane of the engine to terminate in straight parallel edges which lie in planes substantially tangent to the cylinder cooling fins and parallel to the said median plane of the engine.

The uppermost and lowermost cylinder cooling fins have substantially triangular corner portions 65 which join with the flat wall 64 and coact therewith to define a transversely extending air passage through which flows the air leaving the adjacent portion of the shroud, the wall 64 being contiguous to the edge of the adjacent side wall 61 of the shroud so as to form in effect an extension of said shroud wall.

The air directing effect of the flat wall 64 in conjunction with the corner portions 65 of the upper and lower cooling fins is continued by the engine's customary stamped metal name plate 66. A single screw 67 secures the name plate across the side of the cylinder opposite the shroud with one edge of the name plate contiguous to the adjacent edge of the flat wall 64 and its upper and lower edges contiguous to the adjacent edges of the top and bottom cooling fins. The name plate thus coacts with the wall 64 to direct the cooling air and cause it to effectually contact the cooling fins. It will be appreciated that this arrangement eliminates the curved air shield which heretofore was separately attached to the engine.

By virtue of the fact that the wall 64 is cast integrally with the crankcase-cylinder casting and joins with all of the cylinder cooling fins in the manner described, still another very important advantage is obtained, for as will be apparent to those skilled in the die casting art, a portion of the die in which the wall 64 is cast provides an excellent gate through which the molten metal may rapidlyl flow to quickly fill up the portions of the die in which the cylinder per se is cast. This assures the desired metal density in that portion of the casting where imperfections would be most serious.

Also, since the wall 64 is thin and is joined with each of the cylinder cooling fins it provides additional extended surface for the cylinder to thus assure more rapid dissipation of the heat generated in the engine.

It should also be observed that the wall 64 serves to hold the name plate against rotation about its fastening screw. This enables the use of a single screw to hold the name plate in place and the boss 68 into which this fastening screw is threaded can be conveniently formed as an enlargement of one of the cooling fins 45.

Still another advantage of the wall 64 is the protection against breakage which it affords the cooling fins during handling of the engine before the gas tank is mounted.

The fuel tank 69 is conveniently supported by a bracket arm 70 bolted to the top of the cylinder head and a bracket 71 bolted to the outer face of the wall 64 by a screw 72 which is tapped into a boss 73 at the back of the wall 64. Hence, the wall 64 is interposed between the fuel tank and the engine cylinder and shields the fuel tank against the heat radiated from the cylinder, the heat thus intercepted by the wall 64 being carried away by the cooling air flowing across its inner surface.

The ignition system of the engine is of the flywheel magneto type and accordingly the flywheel has a permanent magnet 74 embedded in its rim, the pole pieces 74' of which sweep past the three legs 75, 76 and 77

of a laminated armature 78 having the customary coil 79 mounted upon its center leg 76. In the past where flywheel magnetos have been used on engines of this kind it has been customary to assemble the stator of the apparatus upon a mounting plate which in turn was mounted upon the engine. In the present invention the need for such plate mounting of the stator is eliminated by the fact that the stator armature is bolted directly to the side of the crankcase-cylinder casting, and to this end the casting has four supporting posts 80 extending from the side of the cylinder and into which the fastening screws 81 are screwed. The holes in the armature through which the clamping screws pass are sufficiently large to permit the armature to be adjusted as required to give equal definite air gaps between its two outer legs and the rotor.

One end of the high tension secondary of the coil is, of course, connected to the center terminal of the spark plug through the customary spark plug lead 82 and one end of the primary winding is connected by a lead 83 to one of the contacts of the breaker mechanism indicated generally by the numeral 84 and which, as will be hereinafter more fully described, embodies some rather novel features.

The lead 83 must pass under the rim of the flywheel and to protect the same against contact with the flywheel a combined heat shield and guard 85 is provided. This unit is best illustrated in Figure 1A. It is mounted in place by being clamped between the armature and the posts 80, the clamping screws 81 passing through holes in flanges 86 which extend from opposite edges of the unit. The main body of the unit lies between the coil and the adjacent side of the cylinder and thus constitutes a heat shield to protect the coil from the heat radiated by the cylinder and to aid in this function the unit is stamped from smooth surfaced aluminum or other highly reflective metal.

The wire guarding function of the unit is performed by an arm 87 projecting from the body of the unit and positioned to lie closely adjacent to the side of the engine over the lead 83 as clearly shown in Figures 1 and 2.

Two of the fastening screws 81 by which the stator armature is held in place also serve to mount a stamping 88 which provides a deflector within the air shroud and a mounting 89 for the governor vane (not shown).

The breaker assembly 84 is mounted directly upon the casting side wall 11 and comprises a condenser 90, a breaker arm 91, a pair of normally open breaker contacts or points 92 and 93 and mechanism to effect periodic engagement thereof. One of the features of the breaker mechanism resides in the fact that one of the breaker contacts is mounted directly on one end of the condenser 90. This enables the insulating bushing 90' of the condenser to serve a dual function. Not only does it insulate the ungrounded condenser terminal but also the ungrounded breaker contact. In addition this construction enables the condenser mounting to provide for the adjustment of the breaker point spacing for by sliding the condenser axially one way or the other the spacing of the breaker points is quickly and easily adjusted.

To this effect the condenser and breaker point assembly is seated in a cradle formed by round bottomed notches 94 in a pair of parallel ribs 95 cast integral with the wall 11 at one side of a hub 96. The hub 96 is also integral with the wall 11 and forms part of the bearing for the adjacent end of the crankshaft.

A strap 97 arched across the top of the condenser and drawn down tight by a clamping bolt 98 serves to hold the condenser firmly against displacement from any desired position of axial adjustment. To prevent rotation of the strap 97 about the screw 98 during the tightening thereof and during axial motion of the condenser for breaker point adjustment a projection 99 on the outer end of the strap is received between an abutment 100 and the adjacent rib 95.

Endwise adjustment of the condenser, may entail slight loosening of the screw 98. This done, a screw driver or other similar tool may be inserted between a lug 101 and the adjacent end of the condenser so that using the lug as a fulcrum the condenser may be easily slid in a direction to increase the spacing between the breaker points, and the adjacent boss 120 may be used as a fulcrum for sliding the condenser in the opposite direction to decrease the breaker point spacing.

The lug 101 projects from a boss 102 which is radial to the hub 96 and is bored to slidably receive a breaker arm operating pin 103. This pin engages the underside of the breaker arm and rides upon the adjacent surface of the crankshaft to drop down onto a cam 104 in the crankshaft and thereby enable a breaker spring 105 acting on the arm 91 to momentarily close the breaker contacts once each revolution of the crankshaft, good electrical grounding of the breaker arm being assured by a flexible jumper 91' having one end thereof secured to the arm and its other end secured to the pivot for the arm.

The manner in which the breaker arm 91 is mounted exemplifies the extent to which this invention has gone to reduce the cost of an engine and simplify its assembly. As best shown in Figure 14 the breaker arm is stamped from sheet metal and has a wide flat mounting end 106 with aligned fulcrum edges 107 which are received in a longitudinal groove 108 in a pivot post 109. The post 109 to which one end of the grounding jumper 91' is secured is stepped into a socket 110 in the outer end of a boss 111 cast as an integral part of the wall 11 and a screw 112 passing through the post 109 and threaded into the boss secures the post to the boss.

Correct angular placement of the groove 108 is assured by a small key 113 integral with the boss 111 and extending in from the side of the socket 110 to enter the adjacent end of the groove 108. This locates the post 109 and holds it from turning.

The lead 83 which connects one end of the primary coil with the breaker contact 92, of course, also connects with the adjacent terminal of the condenser, and it is to be understood that the opposite terminal of the condenser is grounded as is also the movable breaker contact (via the jumper 91') and the common terminal of the primary and secondary windings.

The entire breaker mechanism is housed within a dustproof enclosure formed conjointly by a circular rim 114 on the casting wall 11 and a stamped metal cover 115. The cover 115 is in the form of a small inverted cup having a hole in its end wall to accommodate the crankshaft. The edge of this hole is slightly flared and engages a conical edge 116 on the hub 96, and in like manner the peripheral edge of the cup fits a conical edge 118 on the circular rim 114. The parts are of such relative dimensions that upon drawing the cover down in place by two screws 119 threaded into bosses 120 extending up from the wall 11 a firm engagement is first established between the edge of its hole and the hub and thereafter the peripheral edge of the cover is pulled down onto the beveled edge 118 of the circular rim, it being understood that the bottom wall of the cover is sufficiently flexible or resilient to allow such sequential engagement. This achieves a dust-tight fit between the cover and the casting, and to complete enclosure the notch in the edge of the rim 114 through which the lead 83 enters the breaker housing is sealed with a suitable mastic.

To accommodate the mounting for the breaker arm 91 and the condenser 90 the adjacent portions of the end wall of the cover are bulged out as at 121 and 121'.

Crankcase ventilation, as hereinbefore suggested, is accomplished with a minimum loss of oil from the crank case. The need for ventilating the crankcase arises from the fact that as the piston descends it tends to compress the air in the crankcase, and as it rises on its compression stroke there is a certain amount of "blow-by" past the piston rings from the combustion chamber. Thus unless the crankcase is vented the pressure therein builds up and causes undue leakage of oil past the oil seals and gasket joints. The means provided by this invention for ventilating the crankcase not only eliminates such undesirable pressure but in fact actually produces a partial vacuum in the crankcase. To achieve this result without loss of oil from the crankcase the air is lead from the crankcase by a very tortuous passage which includes the valve spring compartment 27 and comprises a hole or port 122 in the bottom wall 26 of this compartment, a pocket 126 formed by a baffle 123 in coaction with adjacent walls of the crankcase and a novel air breather assembly 127 which forms a cover for the valve spring compartment.

As best shown in Figure 20 the port 122 is located

between the plane of connecting rod motion and the end wall 11 of the crankcase. The baffle 123 is formed as an integral part of the crankcase-cylinder casting and projects from its end wall 11 across the mouth of the port, being preferably a continuation of the bottom of the lug-like portion 124 in which the valve tappets are mounted. Since the baffle 123 extends from the casting wall 11 almost to the open side thereof it coacts with the adjacent walls of the casting to define the pocket 126 which forms a tortuous path of communication between the port 122 and a "quite" relatively oil-free zone of the crankcase interior. Hence, very little oil is carried from the crankcase through the port 122. That which does leave the crankcase through this port is trapped by the breather assembly 127 and returned to the crankcase.

The breather assembly 127, as best shown in the exploded perspective view Figure 15, comprises a stamped oblong box 128 having a hole 129 in its bottom wall, the edge of which projects slightly from the bottom wall to provide a valve seat 130. A light flutter valve 131 stamped from fiber or other suitable material coacts with the seat 130 and is loosely held in position by a partition wall 132 and a tongue 134 extending down from the partition wall toward the bottom of the box 128. The partition wall is spaced a fixed distance from the bottom wall of the box by downturned edges 133 and the tongue 134 being formed from the partition wall leaves a hole 135 through which air may freely pass from one side of the partition wall to the other.

A protrusion 136 in the partition wall 132 provided with circumferentially spaced projections 136' holds the flutter valve 131 off the partition wall and the projections keep the valve disc from sticking in its open position. The valve disc is thus always free to float to and from engagement with the valve seat 130 as the pressure in the crankcase alternates between negative and positive. This arrangement permits free expulsion of air from the crankcase and restricts influx of air to the slight amount which can pass through the hole 129 during the interval the valve disc moves from its "open" position to its "closed" position on the seat 130. However, any dirt or foreign matter entrained in the air thus entering the crankcase is trapped by a mass of keratin fiber or other filtering material 137 confined between the partition and a cover 138.

The cover 138 fits over the box 128 and has an air inlet port 139 in its end remote from the hole 135 in the partition wall to thus assure that any air flowing through the device either inward or outward must pass through the filter.

Mounting ears 140 on opposite ends of the cover provide for fastening the entire assembly in position across the mouth of the valve spring pocket or compartment with the box 128 projecting a substantial distance into the compartment as best shown in Figure 3. Any oil which is carried into the box 128 drains back into the valve spring compartment through drain holes 128' and 132' in the box and its partition wall, and these holes are so located that at least one set thereof is always effective regardless of whether the engine is operating with its cylinder vertical, inclined from the vertical, or horizontal.

The air breather assembly thus performs five important functions.

(1) It baffles out the oil remaining in the air expelled from the crankcase.

(2) It drains this oil back to the crankcase.

(3) Its flutter valve enables the maintenance of a partial vacuum in the crankcase.

(4) Its filter traps dirt which might otherwise be carried into the crankcase.

(5) It provides a cover for the valve spring compartment.

Proper lubrication of the crankshaft and cam shaft bearings is an important consideration. In vertical cylinder engines prior to this invention it was customary to mount separate baffles and oil collectors in the crankcase for collecting oil and leading it to the bearings, but with the present invention this function is performed by baffles cast integrally with the cover casting 7 and the opposite wall 11. Thus, considering first the cover 7 (Figure 10) it will be seen that ribs 141 and 142 project perpendicularly from the inner surface of the casting wall and diverge from the top of a boss 143 which forms part of the bearing 13. The ribs 141 and 142 in coaction with the wall of the casting from which they rise thus form a pocket or funnel 144 in which oil collects during operation of the engine to flow down through an opening 145 in the bearing hub into an oil groove 146.

A somewhat similar arrangement of baffle forming ribs 147 and 148 projecting perpendicularly from the inner surface of the casting wall and diverging from the top of the hub 20 provides a pocket 149 in which oil collects to flow through an opening 150 into the bearing 18. The other ribs of the cover casting 7 provide strength and also facilitate the flow of the die cast metal during the casting operation.

A somewhat similar arrangement of baffles is provided on the inner surface of the main casting wall 11 as best shown in Figure 18. Here a rib 151 extending at an angle from the top of the relatively shallow boss 152 which provides the inner end of the bearing 14 collects oil impelled by the rotation of the crankshaft and directs the oil thus collected into an oil groove 153 leading to the bearing 14. For the cam shaft bearing 19 a baffle 154 extends from the top of the boss 21 to the underside of the adjacent baffle 123 to collect the oil which tends to follow around with the cam shaft, and direct the same through a groove 155 into the bearing 19. As in the cover 7 the other ribs with which the inner surface of the wall 11 is provided are primarily for the purpose of strengthening the casting; and all of these ribs help to dissipate heat by conducting it efficiently to cooler parts of the casting.

If the engine is to operate with its cylinder axis horizontal in which event the crankcase cover 8 is used rather than the cover 7, the problem of adequately lubricating the crankshaft and cam shaft is even more difficult. In this case the cover casting 8 must provide a sump for the oil without, however, incurring the risk of losing oil through the bottom crankshaft bearing 13. Accordingly the cover 8, as described hereinbefore, has a deep dish-shaped formation with relatively high side walls 38 extending up from its bottom wall 37 and the bearing 13 is in a boss 156 which rises from the bottom wall 37 to the level of the gasket flange provided by the top edges of the side walls 38. To assure adequate lubrication of this bearing it is equipped with oil grooves having inlets 157 cut radially through the top of the boss 156 so that during operation of the engine oil can readily reach the bearing 13; however, by virtue of the height of the boss 156 leakage of oil past a defective oil seal 15 in the bottom of the bearing 13 when the engine is idle is limited to the amount above the level of the bottom of the inlets 157.

In the same manner the cam shaft bearing 18 has oil grooves with an inlet 158 leading to the bearing to permit the flow of oil thereto.

The baffles which rise from the bottom wall 37 and radiate from the bearing bosses as well as the other baffles, all of which are clearly shown in Figure 5, are principally for strengthening purposes and, of course, also help dissipate heat.

Lubrication of the upper bearings 14 and 19 is effected by an oil slinger 159 of the type disclosed and claimed in Patent No. 2,669,322. This oil slinger consists of a rotary impeller 160 journaled upon a stub shaft 161 and provided with paddles 162 and gear teeth 162' on its periphery. The gear teeth mesh with one of the timing gears so that during operation of the engine the impeller is rotated to cause its paddles to dip into the oil in the sump and throw it upwardly against the casting wall 11 which now forms the top of the crankcase. The angular disposition of the stub shaft is such that oil thrown upwardly by the paddles strikes the top of the crankcase between the bearings 14 and 19; and to facilitate the flow of the oil thus impinging the top of the crankcase to the crankshaft bearing 14 the casting wall 11 has a pocket 163 formed therein in which part of the oil thrown up by the slinger collects to be retained therein by surface tension and flow from the pocket through an oil hole 164 in the bearing wall.

For the cam shaft, enough of the oil splashed up against the top of the crankcase accumulates against the baffle 154 to flow through the oil groove 155.

Proper location of the slinger with respect to the bearings it supplies and the timing gear which drives it is, of course, important and accordingly the stub shaft

161 upon which the slinger is journaled is part of a specially designed die casting 165 (see Figure 7). This die casting has a pair of angularly disposed arms 166 and 167, the former having the stub shaft 161 formed thereon at an angle to the flat top face of the casting. At the junction of the two arms and at the outer end of the arm 167 are pilot bosses 168 and 169 respectively. These pilot bosses enter pilot holes 170 and 171, respectively, provided by counterbores in the outer ends of two post-like bosses 172 formed as an integral part of the main crankcase-cylinder casting (see Figure 18). These post-like bosses are preferably contiguous to the adjacent side wall of the casting and join therewith. The mounting bracket is held in position by screws 173 which pass through the bracket and are threaded into the post-like bosses.

This manner of mounting the oil slinger assures accurate positioning of the same and greatly facilitates the assembly of the engine since at the time that the cover plate 8 is secured to the main crankcase-cylinder casting the slinger is already in proper position whereas if the oil slinger were mounted on the cover it could not be observed during cover attachment, and might be improperly assembled. It should also be noted that this arrangement obviates the need for any special means to hold the impeller on its stub shaft, this function being performed by the cam shaft timing gear with which the impeller gear teeth 162' mesh.

As brought out hereinbefore one of the features of the invention is the fact that the engine may be easily and economically adapted to a wide variety of uses. Practically any mounting requirement or special use can be met by merely designing the crankcase cover to fit. Thus, as already clearly shown, the same engine may be adapted either to general utility (in which case the engine operates with its cylinder axis vertical), or such special purpose as driving the blade of a rotary type lawn mower (in which event the engine operates with its cylinder horizontal) by simply selecting one of two crankcase covers.

To further illustrate this unusual flexibility of adaptation attention is invited to Figures 21, 22 and 23. Figure 21 illustrates how the engine may be equipped with a mechanical governor of the type covered by Patent No. 2,382,952 without in anywise altering the crankcase-cylinder casting. For this purpose a governor gear 175 may be journaled on a shaft carried by the crankcase cover to drive the fly weights 176. Response of these fly weights to centrifugal force, as clearly described in the aforesaid patent, rocks a control shaft 177 which also is mounted in the cover and by its motion adjusts the throttle valve.

In Figure 22 there is illustrated the adaptation of an external type of breaker such as that covered by Patent No. 2,605,753, and as clearly shown the entire unit 178 is mounted upon a crankcase cover.

Even a fuel pump can be added to the engine if desired without necessitating change in the crankcase-cylinder casting for as shown in Figure 23 a pump such as that illustrated in Patent No. 2,496,688 may be readily mounted upon a pad 179 on the cover casting 7 to dispose the actuating arm 180 of the pump in proper relation to the cam 181 on the crankshaft which operates the pump.

From the foregoing description taken in connection with the accompanying drawings, it will be readily apparent that this invention to a large degree has fulfilled the demand made upon the engine industry to supply a lighter, less expensive engine without sacrificing power output, ruggedness or reliability.

What I claim as my invention is:

1. A single cylinder internal combustion engine having a crankcase with two spaced apart side walls, each of which carries a crankshaft bearing, a cylinder and a crankshaft journaled in the bearings with its ends projecting from the crankcase, one end of the crankshaft having a flywheel mounted thereon and the other end being the power take-off end of the shaft, characterized by the fact that: the cylinder and all portions of the crankcase including the wall thereof remote from and facing the cylinder, except that wall of the crankcase which carries the bearing for the power take-off end of the crankshaft is a single casting; and further by the fact that said wall of the crankcase which carries the bearing for the power take-off end of the crankshaft is provided by a cover removably secured to said casting so that said cover is interchangeable with others of different design to adapt the engine to any of a variety of different installations without necessitating alteration of the cylinder-crankcase casting.

2. A single cylinder four-stroke cycle internal combustion engine having a crankshaft, a cam shaft parallel to the crankshaft, a cylinder and a crankcase, through opposite walls of which the ends of the crankshaft pass, one end of the crankshaft having a flywheel thereon and the other end being the power take-off end of the crankshaft, characterized by the fact that: the cylinder and all portions of the crankcase including the wall thereof remote from and facing the cyclinder, except that wall of the crankcase through which the power take-off end of the crankshaft passes, is one casting; by the fact that said wall through which the power take-off end of the crankshaft passes is provided by a cover removably secured to said casting; by the fact that the crankshaft and the cam shaft are supported by said cover and the wall of the casting opposite the cover; and by the fact that the supports for the cam shaft comprise wells in the cover and said opposite wall of the casting.

3. The engine according to claim 2 further characterized by the fact that the cover and the casting wall opposite the cover have bored bosses projecting from their inner faces and comprising the supports for said shafts, said bosses having oil passages therein leading from mouths at their peripheries into their bores; and further characterized by ribs on the inner faces of the cover and the casting wall opposite the cover radiating from said bosses and coacting with the bosses and the wall surfaces from which the bosses and ribs project to form pockets at the mouths of said oil passages for accumulating and directing oil into the passages.

4. The engine defined in claim 2 further characterized by the fact that said cover has a relatively deep depression in its inner face so that when the engine is positioned to operate with its cylinder horizontal and said cover at the bottom of the engine, the depression in its inner face provides an oil sump; and characterized further by the fact that the cover has a boss projecting from its inner face and bored through to provide a bearing for the adjacent end of the crankshaft, said boss extending for substantially the full depth of the depression in the cover so that oil in the depression rising to a level substantially equal to the full depth of the depression, when the engine is used with its cylinder horizontal, will not drain out along the crankshaft when the engine is idle.

5. A single cylinder, four-stroke cycle internal combustion engine adapted for operation with its cylinder horizontal, said engine having in addition to its cylinder a crankshaft, a cam shaft parallel to the crankshaft, and a crankcase with spaced apart top and bottom walls through which the upper and lower ends of the crankshaft pass, said engine being characterized by the fact that: the cylinder and all portions of the crankcase except its bottom wall through which the lower end of the crankshaft passes is one casting; by the fact that said bottom wall comprises a cover having a relatively deep depression removably secured to the casting with the edge of the depression joining the casting on a plane parallel to said top and bottom walls and below the cylinder, by the fact that the cam shaft is supported by the cover and the top wall of the crank case and the bearings for the crankshaft are in said cover and the top wall of the crankcase; further by the fact that the depression in the cover provides an oil sump and has an oil filler port therein communicating with the depression below the top edge thereof with the mouth of the filler port on a level no higher than the edge of the depression so that the level of the oil in the sump will not be above the edge of the depression; and said cover being further characterized by a pair of bosses projecting up from the bottom of its depression, one of said bosses being bored through and providing the bearing for the lower end of the crankshaft, and the other boss having a well, closed at its bottom extending down into it and providing a support for the lower end of the cam shaft, the boss providing the lower crankshaft bearing extending substantially to the level of the edge of the depresison in the cover so that when the engine is idle the oil in the sump will not be drained therefrom through said crankshaft bearing.

6. A single cylinder, four-stroke cycle internal com-

bustion engine adapted for operation with its cylinder horizontal, said engine having in addition to its cylinder a crankshaft, a cam shaft parallel to the crankshaft, and a crankcase with spaced apart top and bottom walls through which the upper and lower ends of the crankshaft pass, said engine being characterized by the fact that: the cylinder and all portions of the crankcase except its bottom wall through which the lower end of the crankshaft passes is one casting; by the fact that said bottom wall comprises a cover, removably secured to the casting and having a relatively deep depression; by the fact that the cam shaft is supported by the cover and the top wall of the crank case and the bearings for the crankshaft are in said cover and the top wall of the crankcase; further by the fact that the depression in the cover provides an oil sump; and said cover being further characterized by mounting means formed integrally therewith for mounting the engine with its cylinder horizontal.

7. The engine defined in claim 6 but wherein said mounting means for the engine comprises a substantially circular flange on the cover having a flat downwardly facing rim concentric to the crankshaft axis and adapted to seat upon a flat surface.

8. The engine defined in claim 6 but wherein said mounting means for the engine extends from the region of the oil sump towards the cylinder head to thereby enable the mounting means to provide a large mounting area without greatly increasing the outline of the engine.

9. The engine defined in claim 5 further characterized by the provision of a rotary oil slinger having a plurality of paddles on its periphery and having gear teeth; a mounting bracket for the oil slinger having a stub shaft upon which the oil slinger is freely journaled; and means securing said mounting bracket to the cylinder-crankcase casting, with the gear teeth of the oil slinger in mesh with one of the timing gears of the engine and with the paddles dipping into the oil sump provided by the depression in the cover, said mounting bracket so positioning the oil slinger that oil thrown upwardly therefrom strikes the top wall of the cylinder-crankcase casting adjacent to the crankshaft and the cam shaft bearings therein.

10. In an internal combustion engine adapted for operation with its cylinder horizontal: a crankcase comprising complementary main and cover castings, the main casting having the cylinder of the engine cast integrally therewith, said castings being joined together on a plane of parting parallel to the cylinder axis and below the cylinder; mounting means formed integrally with the cover casting for mounting the engine with its cylinder horizontal and the cover casting therebelow, said cover casting having a relatively deep depression extending down from said plane of parting to provide an oil sump; bearings in the bottom wall of the cover casting and the top wall of the main casting for the crankshaft and the cam shaft of the engine; a rotary oil slinger having paddles on its periphery and gear teeth for meshing engagement with one of the timing gears of the engine; a mounting bracket for the oil slinger having a stub shaft upon which the oil slinger is freely journaled; and means securing said mounting bracket to the main casting in position to have the gear teeth on the oil slinger mesh with one of the timing gears of the engine and with the paddles traveling in an orbit which projects a substantial distance down into the oil sump in the cover casting to thereby dip into the oil in said sump and throw the same upwardly into the crankcase interior, said bracket so positioning the oil slinger that oil thrown upwardly therefrom strikes the top wall of the main casting adjacent to the crankshaft and cam shaft bearings therein.

11. The engine defined in claim 10 further characterized by the provision of an oil receiving pocket in the top wall of the main casting in position to receive oil thrown upwardly by the oil slinger; and an oil passage leading from said pocket to the crankshaft bearing in said top wall of the main casting.

12. In a horizontal engine: a crankcase comprising complementary main and cover castings joined on a horizontal plane parallel to the axis of the cylinder but below the cylinder so that the opposite walls of said castings provide the top and bottom respectively of the crankcase; mounting means on the cover casting for mounting the engine with its cylinder horizontal and the cover casting lowermost, said cover casting having a depression therein providing an oil sump beneath th plane of parting between the two castings, the top wal of the main casting and the bottom wall of the cover casting having bearings therein for the crankshaft and the cam shaft; a rotary oil slinger for lifting oil out of the sump and throwing it upwardly against the top wall of the main casting; a mounting bracket for the rotary oil slinger having a stub shaft upon which the oil slinger is journaled; and means fastening said mounting bracket to the main casting with the oil slinger positioned to dip into the sump provided by the cover casting and throw oil lifted therefrom against the top wall of the main casting; and means for driving the rotary oil slinger.

13. In an internal combustion engine of the character described: a crankcase defined partially by a hollow casting having an open bottom and a closed top wall and having the cylinder of the engine formed integrally therewith with its axis parallel to the plane of the open bottom and the closed top wall; an oil sump removably secured to and closing the open bottom of said casting; parallel crankshaft and cam shaft bearings in the top wall of the casting and in the oil sump; a crankshaft having a timing gear thereon and a cam shaft having a timing gear thereon journaled in said bearings with their timing gears meshing and with at least one of the timing gears adjacent to the plane of parting between the casting and the oil sump; a rotary oil slinger having paddles on its periphery and having gear teeth adapted to mesh with the teeth of said timing gear; a mounting bracket for the rotary oil slinger having a stub shaft upon which the oil slinger is journaled; and means mounting said bracket upon the crankcase casting including interengaging locating means on the bracket and the casting whereby said bracket is secured in a position disposing the oil slinger with its gear teeth in mesh with the said timing gear and its paddles dipping down into the oil sump to throw oil upwardly against the top wall of the casting.

14. In an engine of the character described: a cylinder and a crankcase formed as one casting, the crankcase being open at its bottom; a cover closing the open bottom of the crankcase, said cover having a depression therein providing an oil sump for the engine; bearings for the crankshaft of the engine carried by the cover and the wall of the crankcase opposite the cover; said cover having an oil filler port provided by a well extending down from the top of the cover alongside the depression in the cover, the top of said well providing the mouth of the port and lying substantially on a plane with the top edge of the depression; and the cover having an oil drain port in its bottom provided by a bore parallel to the oil filler port but lying between said port and the adjacent wall of the depression and breaking through both the wall of the depression and the oil filler port to thereby communicate the oil filler port with the interior of the depression; and removable caps for closing both the oil filler port and said oil drain port.

15. In an engine of the character described, the structure set forth in claim 14 further characterized by the provision of a boss projecting from the bottom of the depression in the cover, said boss being bored through and providing the bearing for the lower end of the crank shaft and having a height to reach substantially to the level of the mouth of the filler port so that oil in the sump cannot drain out through the lower crank shaft bearing when the engine is idle.

16. A single cylinder four-stroke cycle internal combustion engine having a crankshaft, a cylinder and a crank case through opposite walls of which the ends of the crankshaft pass, one end of the crankshaft having a flywheel thereon and the other end being the power take-off end of the crankshaft, characterized by the fact that: the engine is designed to be used with its cylinder horizontal with the walls of the crankcase through which the crankshaft passes being the top and bottom walls of the crankcase and with the flywheel adjacent to the top wall and the power take-off end of the crankshaft projecting down from the bottom wall; by the fact that the cylinder and all portions of the crankcase including the wall thereof remote from and facing the cylinder, except the bottom wall through which the power take-off end of the crankshaft passes is one integral casting; by the fact that said bottom wall is provided by a cover removably secured to said casting; by the fact that the crank shaft and the cam shaft are supported by said cover and the top wall of the crankcase; by the fact that said cover has a rela-

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tively deep upwardly opening depression which provides an oil sump; and characterized further by the fact that the cover has a boss projecting upwardly from its inner face and bored through to provide a bearing in which the lower end of the crankshaft is rotatably supported, said boss extending for substantially the full depth of the depression in the cover so that oil in the depression rising to a level equal to the full depth of the depression will not drain out along the crankshaft when the engine is idle.

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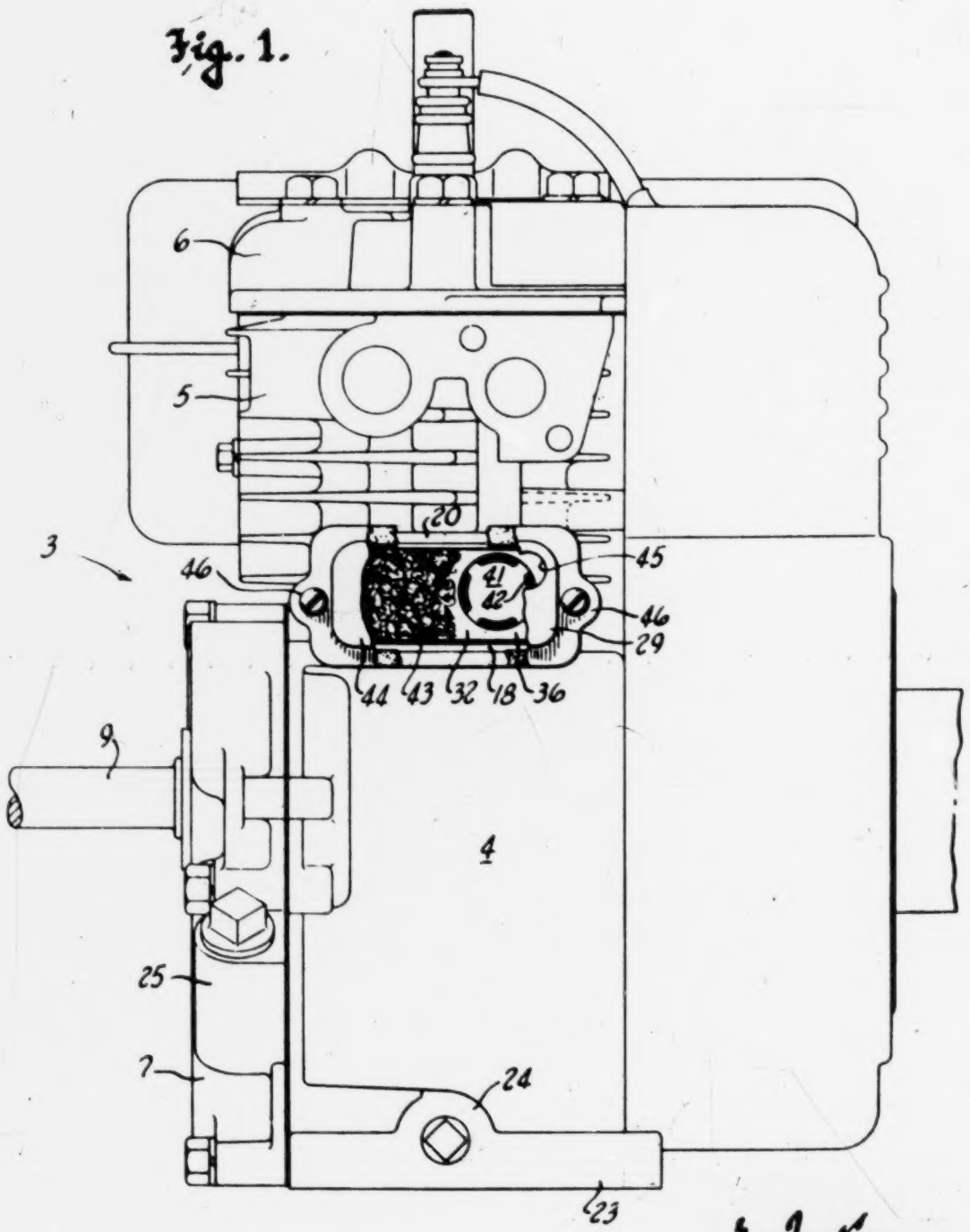
BREATHER FOR AIR-COOLED INTERNAL-COMBUSTION ENGINES

Original Filed May 11, 1954 4 Sheets-Sheet 1

Fig. 1.



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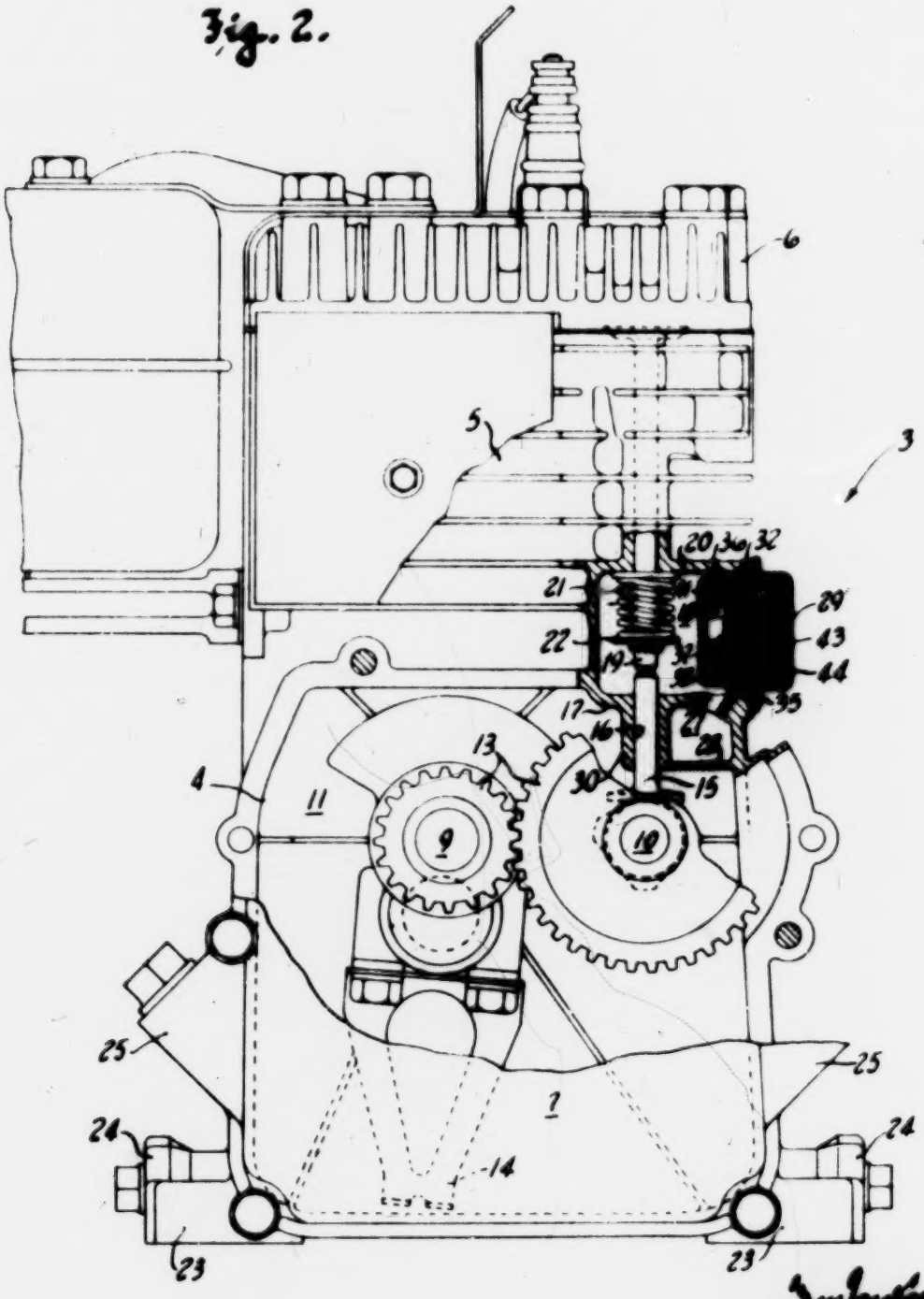
BREATHER FOR AIR-COOLED INTERNAL-COMBUSTION ENGINES

Original Filed May 11, 1954 4 Sheets-Sheet 2

Fig. 2.



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Nov. 9, 1954 L. J. LECHTENBERG 2,693,791

BREATHER FOR AIR-COOLED INTERNAL-COMBUSTION ENGINES

Original Filed May 11, 1954 4 Sheets-Sheet 3

Fig. 3.

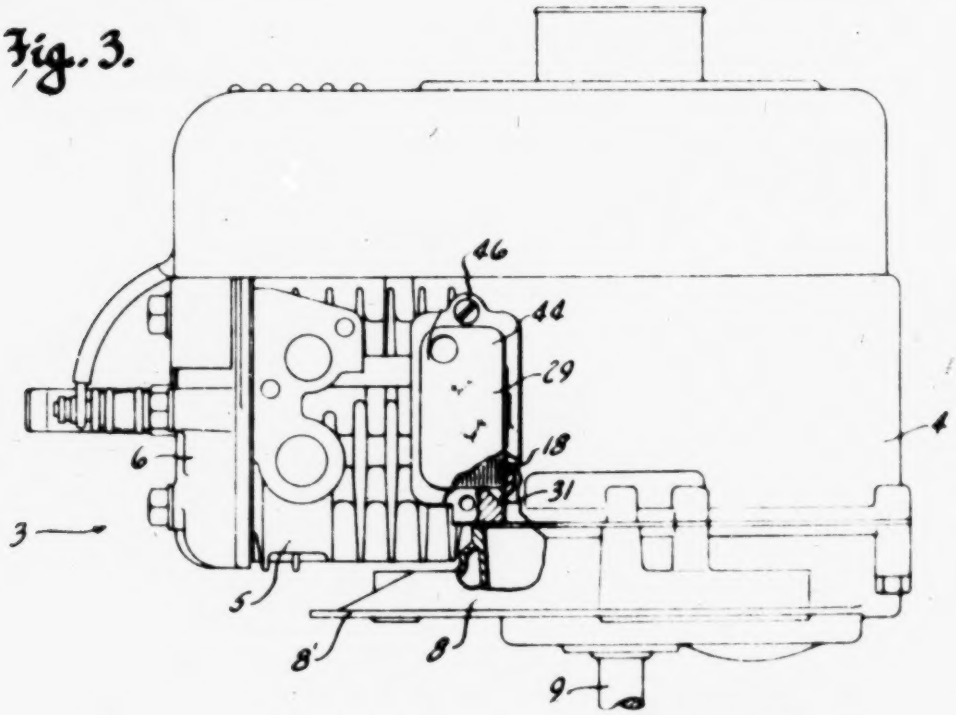


Fig. 4.

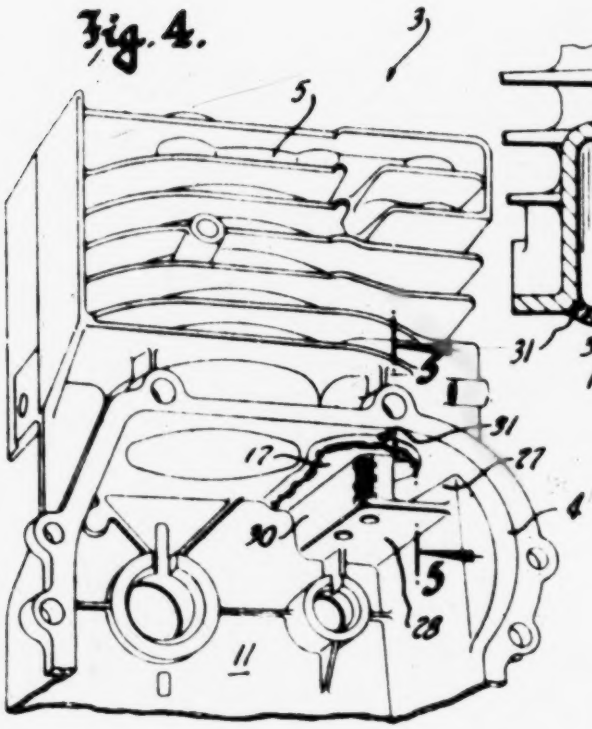
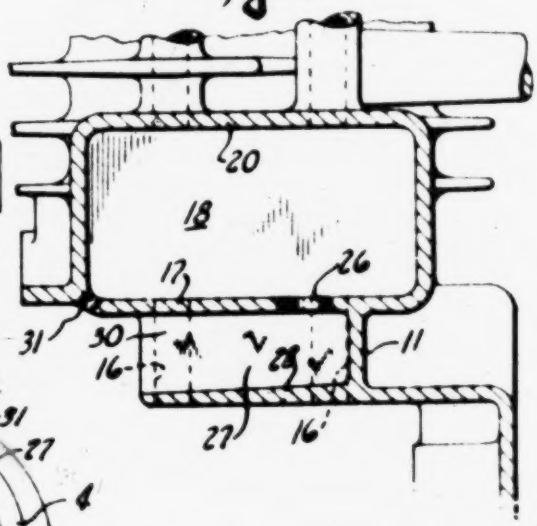


Fig. 5.



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BREATHER FOR AIR-COOLED INTERNAL COMBUSTION ENGINES

Original Filed May 11, 1954 4 Sheets-Sheet 4

Fig. 6.

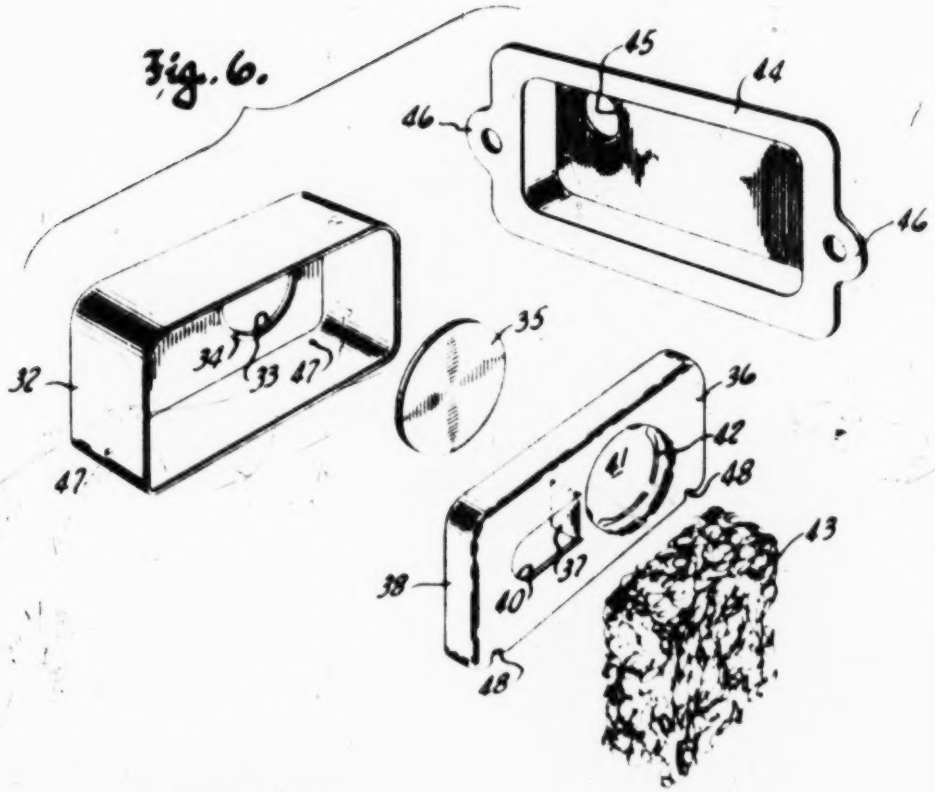
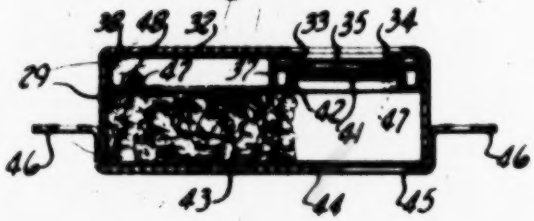


Fig. 7.



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BREATHER FOR AIR-COOLED INTERNAL-COMBUSTION ENGINES

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Application August 9, 1954, Serial No. 448,406

5 Claims. (Cl. 121—194)

This invention relates to internal combustion engines and refers more particularly to single cylinder, air cooled, four-stroke cycle engines of the type now widely used on power lawn mowers and many other well-known appliances.

More specifically, this invention concerns the manner in which the crankcase of the engine forming the subject matter of the pending application Serial No. 354,056, is vented; this application being a division of said application.

One of the objects of this invention is to provide assurance against oil leakage from the crankcase through the necessary breather opening by the simple expedient of a properly placed baffle cast integral with the crankcase.

With a view toward improving the air breather for the crankcase it is another object of this invention to vent the crankcase through a pocket or compartment in which the valve springs are located and with which the tappet openings communicate, and to control the flow of air to and from this valve spring pocket or compartment by means of a novel breather valve assembly formed as a cover for the valve spring compartment.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a side view of the engine of this invention with a part of the cover for the valve spring compartment broken away, and with the carburetor removed for clarity;

Figure 2 is a view of the power take-off end of the engine, with a substantial part of the crankcase cover broken away and parts of the cylinder-crankcase casting broken away and shown in section;

Figure 3 is a side view of the engine adapted for horizontal operation, that is, with its cylinder horizontal and showing the same equipped with a crankcase cover especially designed to adapt the engine for use as the power unit of a rotary type lawn mower, parts of said view being broken away and shown in section to illustrate how oil which may enter the valve spring compartment is drained therefrom when the engine is adapted for horizontal operation;

Figure 4 is a perspective view of a portion of the cylinder-crankcase casting looking into the interior of the crankcase and illustrating especially the baffle arrangement by which the splashing of oil through the breather opening is prevented;

Figure 5 is a detail sectional view through Figure 4 on the plane of the line 5—5;

Figure 6 is an exploded perspective view of the air breather assembly which controls the venting of the crankcase interior, and

Figure 7 is a longitudinal sectional view through the air breather assembly.

Referring now particularly to the accompanying drawings in which like numerals indicate like parts throughout the several views, the numeral 3 designates generally the crankcase-cylinder casting of the engine, consisting of a crankcase portion 4 and a cylinder 5. This main casting together with a cylinder head 6 and a crankcase cover casting 7 or 8 (depending upon the intended use of the engine) comprises the entire body of the engine. For ordinary general utility where an upright disposition of the engine is desirable, the crankcase cover 7 is used, but where the engine is intended to operate with its cylinder axis horizontal as in the driving units of rotary type lawnmowers, and as shown for instance in Figure 3, the cover 8 is used.

The bearings for the engine crankshaft 9 and its cam shaft 10 are mounted in the cover casting and the end wall 11 of the crankcase-cylinder casting opposite the cover, and to enable adapting the engine to any one of a wide variety of uses without need for changing the crankcase-cylinder casting the flywheel 12 is mounted upon the end of the crankshaft which protrudes from the casting wall 11 and the opposite power take-off end of the crankshaft protrudes from the cover casting regardless of which of the two types of covers is employed.

The crankcase-cylinder casting 3, the cylinder head 6 and the crankcase cover 7–8 are cast of aluminum alloy, preferably as die castings, and the crankshaft and cam shaft run directly in bearings bored in the cover casting and the opposite wall of the crankcase-cylinder casting. In other words, the bearings are not bushed, but can be bored out to receive bushings (not shown) after the engine has been in service long enough to cause serious bearing wear.

The cam shaft 10, which is of conventional construction is driven from the crankshaft by the usual set of timing gears 13 which are located adjacent to the crankcase cover, and when the engine is intended for general utility, the connecting rod has an oil splashing dipper 14 secured thereto to effectively splash the oil contained in the crankcase up into all parts of the crankcase interior and into the cylinder.

Valve tappets 15 operated by the cam shaft are slidably received in relatively long holes 16 drilled through a wall 17 of the crankcase-cylinder casting and a boss 30 depending therefrom. The outer ends of these holes open to a valve spring pocket or compartment 18 in which the tappets abut the valve stems 19 to lift the valves in the customary manner. The valve stems enter the compartment 18 through its top wall 20 and the valve springs 21 are confined between this top wall 20 and spring seats 22 on the lower ends of the valve stems.

The valve spring pocket or compartment 18 not only affords a convenient enclosure for the valve springs but, as will be hereinafter more fully described, forms part of the means by which the crankcase interior is ventilated.

If the engine is intended for operation with its cylinder vertical the crankcase-cylinder casting 3 is provided with integral mounting feet 23 and bosses 24 at opposite sides of the casting, either one of which may be drilled and tapped to provide an oil drain port. But when the engine is intended for operation with its cylinder axis horizontal, the feet and drain port are not needed and hence those portions of the die or mold in which the feet and bosses are formed would be blocked off. Also, when the engine is intended for general utility and the cover 7 is employed the oil filler port may be located at either side of the engine, and to provide for such alternate location the cover casting 7 has a pair of bosses 25 either of which may be drilled and tapped to provide the oil inlet port.

If the engine is intended for operation with its cylinder horizontal and the other cover casting 8 is used both the oil inlet port and the oil drain port are in the cover casting which has a relatively deep dish-shaped formation and thus provides an oil sump for the engine. The gasket face formed by the outer edges of the side walls of the cover 8 has the same shape as the gasket face formed by the outer edges of the side walls of the cover casting 7 so as to interchangeably fit the open side of the crankcase.

If the engine is intended for use as the power unit

of a rotary type lawn mower the cover casting 8 has a mounting flange 8' cast integrally therewith. This flange seats upon and is secured to the deck of the lawn mower (not shown) to firmly mount the engine with the power take-off end of its crankshaft extending down below the deck.

Crankcase ventilation, as hereinbefore suggested, is accomplished with a minimum loss of oil from the crank case. The need for ventilating the crankcase arises from the fact that as the piston descends it tends to compress the air in the crankcase, and as it rises on its compression stroke there is a certain amount of "blow-by" past the piston rings from the combustion chamber. Thus unless the crankcase is vented the pressure therein builds up and causes undue leakage of oil past the oil seals and gasket joints. The means provided by this invention for ventilating the crankcase not only eliminates such undesirable pressure but in fact actually produces a partial vacuum in the crankcase. To achieve this result without loss of oil from the crankcase the air is led from the crankcase by a very tortuous passage which includes the valve spring compartment 10 and comprises a hole or port 26 in the bottom wall 17 of this compartment, a pocket 27 formed by a baffle 28 in coaction with adjacent walls of the crankcase and a novel air breather assembly 29 which forms a cover for the valve spring compartment.

As best shown in Figure 5 the port 26 is located between the plane of connecting rod motion and the end wall 11 of the crankcase. The baffle 28 is formed as an integral part of the crankcase-cylinder casting and projects from its end wall 11 across the mouth of the port, being preferably a continuation of the bottom of the depending boss 30 through which the valve tappets pass. Since the baffle 28 extends from the casting wall 11 almost to the open side of the casting it coacts with the adjacent walls of the casting to define the pocket 27 which forms a tortuous path of communication between the port 26 and a "quiet" relatively oil-free zone of the crankcase interior. Hence, very little oil is carried from the crankcase through the port 26. That which does leave the crankcase through this port is trapped in the valve spring compartment 10 by the breather assembly 29, to be returned to the crankcase when the engine is in its vertical position by simply flowing back through the port 26 into the pocket 27 and from there over the edge of the baffle 28, and when the engine is in its horizontal position, by flowing through a drain port 31 which leads from the compartment 10 to the crankcase interior.

The breather assembly 29 as best shown in the exploded perspective view Figure 6, comprises a stamped oblong box 32 having a hole 33 in its bottom wall, the edge of which projects slightly from the bottom wall to provide a valve seat 34. A lighter flutter valve 35 stamped from fiber or other suitable material coacts with the seat 34 and is loosely held in position by a partition wall 36 and a tongue 37 extending down from the partition wall toward the bottom of the box 32. The partition wall is spaced a fixed distance from the bottom wall of the box by downturned edges 38, and the tongue 39 being formed from the partition wall leaves a hole 40 through which air may freely pass from one side of the partition wall to the other.

A protrusion 41 in the partition wall 36 provided with circumferentially spaced projections 42 holds the flutter valve 35 off the partition wall and the projections keep the valve disc from sticking in its open position. The valve disc is thus always free to float to and from engagement with the valve seat 34 as the pressure in the crankcase alternates between negative and positive. This arrangement permits free expulsion of air from the crankcase and restricts influx of air to the slight amount which can pass through the hole 33 during the interval the valve disc moves from its "open" position to its "closed" position on the seat 34. However, any dirt or foreign matter entrained in the air thus entering the crankcase is trapped by a mass of keratin fiber or other filtering material 43 confined between the partition and a cover 44.

The cover 44 fits over the box 32 and has an air inlet port 45 in its end remote from the hole 40 in the partition wall to thus assure that any air flowing through the device either inward or outward must pass through the filter.

Mounting ears 46 on opposite ends of the cover provide for fastening the entire assembly in position across the mouth of the valve spring pocket or compartment with the box 32 projecting a substantial distance into the compartment as best shown in Figure 2. Any oil which is carried into the box 32 drains back into the valve spring compartment through drain holes 47 and 48 in the box and its partition wall, and these holes are so located that at least one set thereof is always effective regardless of whether the engine is operating with its cylinder vertical, inclined from the vertical, or horizontal.

The air breather assembly of this invention thus performs five important functions.

(1) It baffles out the oil remaining in the air expelled from the crankcase.

(2) It drains this oil back to the crankcase.

(3) Its flutter valve enables the maintenance of a partial vacuum in the crankcase.

(4) Its filter traps dirt which might otherwise be carried into the crankcase.

(5) It provides a cover for the valve spring compartment.

What is claimed as my invention is:

1. In an internal combustion engine of the character described having a cylinder and a crankcase cast as one unit with the cylinder extending from one wall of the crankcase, said wall of the crankcase having an air breather hole therein near the junction of said wall with an adjacent side wall of the crankcase for communicating the interior of the crankcase with the atmosphere; and a baffle inside the crankcase cast integrally therewith and extending across the corner at the junction of said two walls and across the mouth of said air breather hole to coact with said two walls to define a tortuous passage leading from the mouth of said air breather hole to a relatively oil free zone of the crankcase interior to thereby minimize loss of lubricant from the crankcase through said air breather hole.

2. In an internal combustion engine of the character described having a cylinder and a crankcase cast as one unit with the cylinder extending from one wall of the crankcase and with the crankcase having an end wall substantially parallel with the plane of the connecting rod motion, the first designated wall of the crankcase from which the cylinder extends having an air breather hole therein near the junction of said first designated wall with an adjacent side wall of the crankcase and between the plane of connecting rod motion and said end wall of the crankcase for communicating the interior of the crankcase with the atmosphere; and a baffle inside the crankcase cast integrally therewith and extending across the corner at the junction of said first designated wall and said side wall and across the mouth of said air breather hole and projecting from the end wall of the crankcase a substantial distance beyond the plane of connecting rod motion to coact with said two corner defining walls to form a tortuous passage leading from the mouth of said air breather hole to a relatively oil free zone of the crankcase interior to thereby minimize loss of lubricant from the crankcase through said air breather hole.

3. An air breather unit for internal combustion engines, comprising: a stamped sheet metal plate adapted to be secured as a cover over an opening in a wall of the engine; a box-like stamping having a hole in its bottom, the edge of said hole being raised a slight distance above the inner surface of said bottom wall to provide a valve seat; means connecting the box-like stamping with said cover plate, said cover plate having a hole therethrough; a light valve disc within the box-like stamping; means loosely confining said disc to a zone over the valve seat so that said disc may be moved off and onto the seat; a partition wall inside the box-like enclosure between its bottom wall and the cover plate and positioned to block direct passage through said holes and provide a tortuous passage from one hole to the other; and a filter between the partition wall and the cover plate through which all air flowing through the unit must pass.

4. In an internal combustion engine of the character described, having a cylinder and crankcase cast as one integral unit with the cylinder extending outwardly from one wall of the crankcase; a boss extending inwardly from said wall of the crankcase between its junction with the cylinder and the junction of said wall and an adjacent side wall of the crankcase; said boss having holes therethrough to accommodate the valve actuating tappets of

the engine; the portion of said first designated crankcase wall which lies between the cylinder and said boss having an air breather hole therethrough for communicating the interior of the crankcase with the atmosphere; and a baffle inside the crankcase cast integrally therewith and extending from said boss towards the designated side wall of the crankcase across the corner formed by its junction with the first designated crankcase wall and across the mouth of the air breather hole to coact with said two walls and the boss to define a tortuous passage leading from the mouth of the air breather hole to a relatively oil free zone of the crankcase interior to thereby minimize loss of lubricant from the crankcase through said air breather hole.

5. The engine defined in claim 4 further characterized by the fact that the crankcase has an end wall substantially parallel with the engine's connecting rod motion and joining said two designated walls of the crankcase;

by the fact that the boss and the baffle also join said end wall and project substantially perpendicularly therefrom for a substantial distance beyond the plane of connecting rod motion; and by the fact that the air breather hole is located between the plane of connecting rod motion and said end wall of the crankcase.

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2,607,332	Boema	Aug. 19, 1952

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,693,791 November 9, 1954

Leo J. Lechtenberg

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 2, strike out "the cylinder" and insert instead --said adjacent side wall of the crank case--.

Signed and sealed this 8th day of March, 1955.

(SEAL)
Attest:

E. J. MURRY

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

Certificate of Correction

Patent No. 2,693,791 November 9, 1954

Leo J. Lechtenberg

It is hereby certified that error appears in the above numbered patent requiring correction as follows:

In the headings to the drawings, Sheets 1, 2, 3, and 4, line 3, in each instance, for "Original Filed May 11, 1954" read *Original Filed May 11, 1953*;

and that the said Letters Patent should be read as corrected above.

Signed and sealed this 11th day of January, A. D. 1955.

ARTHUR W. CROCKER,
Assistant Commissioner of Patents.

[SEAL]

310,082 AMENDED SPECIFICATION 1 SHEET

This Drawing is a reproduction of the Original on a reduced scale.

Fig.1.

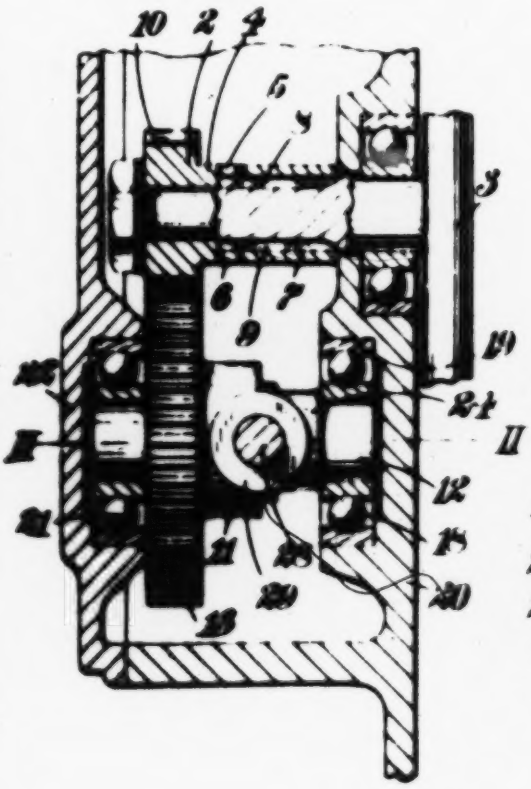


Fig.2.

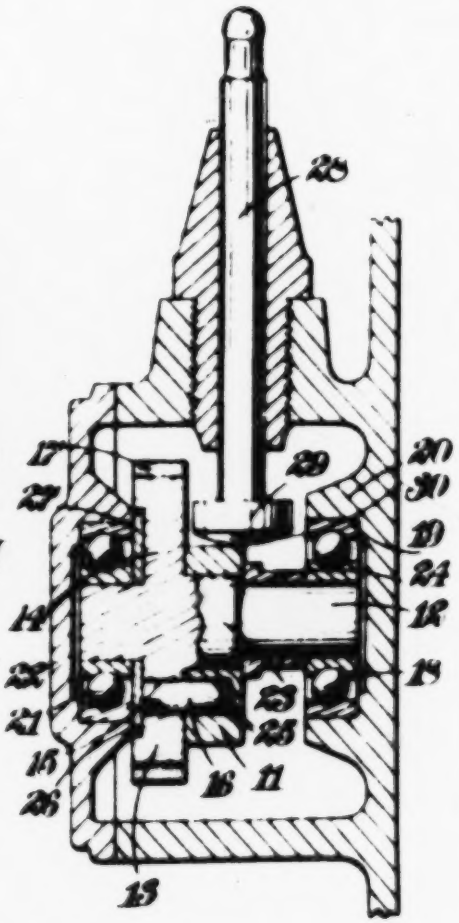
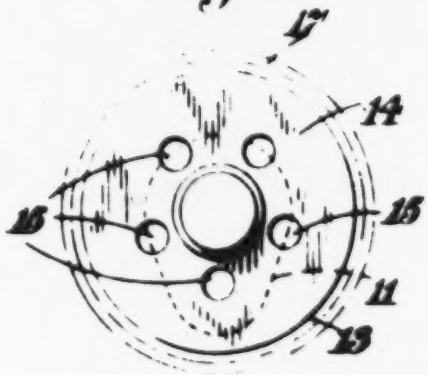


Fig.3.



Charles & Read Ltd Photo Litho

AMENDED SPECIFICATION.

as amended under Section 8 of the Patents and Designs Acts, 1907 to 1928.

PATENT SPECIFICATION

310,082

Application Date: Jan. 20, 1928. No. 1910/28.

Complete Left: Oct. 20, 1928.

Complete Accepted: April 22, 1929.

PROVISIONAL SPECIFICATION.

Improvements in Timing Mechanism for Cams or other Rotating Members.

We, CYRIL GEORGE PULLIN, a British Subject, of 11, Small Street, Bristol, and HARRY LAURENCE GROOM, a British Subject, of "The Homestead", Thrale Road, Streatham, London, S.W.16, do hereby declare the nature of this invention to be as follows:—

This invention relates to timing mechanism for cams or other rotating members, and its principal object is to provide in a simple, inexpensive and effective manner for fine angular adjustments of the cams of internal combustion engines, although the invention may equally well be applied to other kinds of engines or machines.

According to this invention, in the gear train driving the cam an angular adjustment device is provided between each of two or more gears and the member on which they are mounted.

This cheapens manufacture as it enables a very fine adjustment to be obtained from two relatively coarse ones which can be produced by comparatively simple means without involving highly skilled labour. Obviously, however, where finer adjustments still are desirable, one or both can initially be manufactured as a relatively fine adjustment, so that the results obtainable are of a far more delicate nature.

In one method of carrying out the invention for an internal combustion engine, the driving pinion for operating the cam mechanism is formed separately from the crankshaft and is provided with one or more keyways for selective engagement with a key on the crankshaft, and is spaced as to provide thereby for an angular adjustment of the pinion on the crankshaft by some fraction of the angular pitch of the pinion teeth.

Where the engine is of the single cylinder type and each valve cam is on a separate spindle, the timing gear or cam pinion engaging the crankshaft pinion is formed integrally with the spindle, and the cam is loosely mounted upon the spindle to abut the timing gear. In the web of the latter is provided a convenient number of holes, for example five, and these are selectively engageable by a pin projecting from the side of the cam. The spacing of the holes in the timing gear is such that by this selective engagement an angular movement of the cam in respect to the indexing of the teeth is varied by a fraction of the angular pitch of the tooth dependent upon the number of holes provided. By this arrangement therefore, an exceedingly fine adjustment of the cam in relation to the crankshaft can be made notwithstanding that each separate adjustment (i.e. driving pinion on the crankshaft and the cam in relation to the camshaft timing gear) may be relatively coarse. Manufacture is thus cheapened very considerably, for it is possible to make the pinion and shaft from a relatively soft and cheap material, whilst the separately formed cam can be case-hardened and ground. Furthermore, numerous cam forms can be stocked and they can be interchanged on the engine with very little delay or expense.

It is to be understood, however, that if desired the cam pinion, the spindle and the cam can be made in three separate parts, the pinion being secured to the shaft as by keying or any other preferred method.

A preferred arrangement where the cam pinion and spindle are in one is to provide ball bearings for each end of the spindle, mounting one of these bearings in a recess in the wall of the crankcase

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and the other in a cover which closes the casing around the timing gears. The cam pinion is adjacent the outer ball bearing, and on the inner side of it is a slightly enlarged seating for the cam, which is separately formed and engages thereon by a light press fit. It is retained in position by a tubular distance piece, one end of which bears against the side of the cam and the other against the inner race of the inner ball bearing.

In the side of the cam is a blind hole, and in this is mounted a pin adapted selectively to engage one of the holes above referred to provided around the disc of the cam pinion. In the face of this latter remote from the cam, is sunk an annular recess, and in this recess fits a washer which bears against the end of the pin connecting the cam and cam pinion, preventing the pin moving out of position. This washer lies against the adjacent face of the outer ball bearing and therefore is secure when the timing gear cover is in place.

The cam tappet preferably has a circular head which bears on the cam and is of a diameter approximately double the width of the cam. The axis of the tappet is offset (i.e. to one side of the centre of the width of the cam) so that rotation of the tappet is thereby ensured by the action of the cam, and wear of the head is equalized.

It will be seen, therefore, that the invention provides a very simple and inexpensive method of timing-cam mechanism, and of so forming the cam that it is readily interchangeable. It is preferred that where the inlet and the exhaust valve cams are carried by separate spindles the adjustment device should be provided for each cam.

Dated this 19th day of January, 1928.

ERIC W. WALFORD,
Fellow of the Chartered Institute of Patent Agents,
19, Hertford Street, Coventry,
Agent for the Applicants.

COMPLETE SPECIFICATION (AMENDED).

Improvements in Timing Mechanism for Cams or other Rotating Members.

We, CYRIL GEORGE PULLIN, a British Subject, of the Ascot Motor & Manufacturing Company Limited, Letchworth, Hertfordshire, formerly of 11, Small Street, Bristol, and STANLEY LAURENCE GROOM, a British Subject, of "The Homestead", Thrale Road, Streatham, London, S.W.16, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to timing mechanism for cams or other rotating members, of the kind which comprises two or more toothed engagements of different pitches between elements of the gearing of internal combustion engines by means of which a very fine angular adjustment of a cam or other rotating member driven thereby can be obtained. The object of the invention is to provide a mechanism of this kind particularly applicable to the valve operating gear of a motor cycle engine.

According to this invention, in the gear train driving a cam or other rotating member an angular adjustment device is provided between each of two or more gears and the members on which they are mounted or to which they are operatively connected.

This cheapens manufacture as it enables a very fine adjustment to be obtained from two or more relatively coarse ones which can be produced by comparatively simple means without involving highly skilled labour. Obviously, however, where finer adjustments still are desirable, one or both can initially be manufactured as a relatively fine adjustment, so that the results obtainable are of a far more delicate nature.

In the accompanying drawings illustrating the application of the invention to the cam timing mechanism of an internal combustion engine.

Figure 1 is a fragmentary sectional plan of the timing gear casing and its enclosed parts, showing also the adjustment device between the driving pinion and its shaft.

Figure 2 is a section on the line II – II of Figure 1 showing the adjustment device between a cam and the pinion coupled to it, and

Figure 3 is an end view of the cam pinion, with the cam indicated by dotted lines.

In this construction the driving pinion 2 for operating the cam mechanism is formed separately from the crankshaft 3 and is provided on the end of its [illegible]

position 4 with five spaced dogs 5 for selective engagement with co-acting dog parts 6 on the adjacent end face of a sleeve 7. This sleeve has formed on its inner periphery longitudinal splines 8 (for example, six in number) adapted to be engaged selectively with a similar number of co-acting splined parts 9 on the crankshaft 3.

The dogs 5 on the pinion 2 are so spaced in relation to the teeth 10 thereon as to provide thereby for an angular adjustment of the pinion about the crankshaft by some fraction of the angular pitch of the pinion teeth. Such desired spacing is obtained if the number of dogs 5 is not an integer multiple or sub-multiple of the number of teeth on the pinion. The same remark applies to the relationship of the number of splines 8 to the number of pinion teeth, whilst for the purpose of this invention the number of splines must also differ from the number of dogs, for example in a known manner by plus or minus one.

The dogs and splines taken separately give relatively coarse adjustment of the pinion and the sleeve respectively but used in conjunction a much finer adjustment is possible, the method adopted being to change the angular position of the pinion in relation to the sleeve only, or that of the sleeve and pinion (as one piece) in relation to the crankshaft only, or to make a change at both the dogs and the splines.

The timing gear or cam pinion 13 engaging the crankshaft pinion 2 is formed integrally with its spindle 12, and the cam 11 is loosely mounted upon the spindle to abut the timing gear. In the web 14 of the latter is provided a convenient number of holes 15 not forming an integer sub-multiple of the number of teeth in the pinion 13, for example five, and these are selectively engageable by a pin 16 projecting from the side of the cam. The spacing of the holes 15 in the timing gear is such that by this selective engagement an angular movement of the cam in respect to the meshing of the teeth 17 is varied by a fraction of the angular pitch of the teeth depending upon the number of holes provided.

By using these three adjustments, therefore, an exceedingly fine angular movement of the cam 11 on the crankshaft 3 can be made, it being understood that each separate adjustment may be

shaft 12 from

Furthermore, numerous cam forms can be stocked and they can be interchanged on the engine with very little delay or expense.

It is to be understood, however, that if desired the cam pinion 13, the spindle 12 and the cam 11 can be made in three separate parts, the pinion being secured to the shaft as by keying or any other preferred method.

A preferred arrangement where the cam pinion and spindle are in one as shown is to provide ball bearings for each end of the spindle, mounting one of these bearings 18 in a recess 19 in the wall 20 of the crankcase and the other 21 in a cover 22 which closes the casing around the timing gear. The cam pinion is adjacent the outer ball bearing 21, and on the inner side of it is a slightly enlarged seating 23 for the cam 11, which is separately formed and engages thereon by a light press fit. It is retained in position by a tubular distance piece 24, one end of which bears against the side of the cam and the other against the inner race of the inner ball bearing.

In the side of the cam 11 is a blind hole 25, and in this is mounted the pin 16 adapted selectively to engage one of the holes 15 in the cam pinion. In the face of this latter remote from the cam is sunk an annular recess 26, into which fits a washer 27 adapted to bear against the end of the pin 16 and prevent it moving out of position. This washer lies against the adjacent face of the outer ball bearing 21 and therefore is secure when the timing gear cover 22 is in place.

The cam tappet 28 preferably has a circular head 29 with a curved surface 30 which bears on the cam 11 and the head is of a diameter approximately double the width of the cam. The axis of the tappet is offset as shown, i.e., to one side of the centre of the width of the cam. When wear commences the tappet will be rotated by the action of the cam and wear upon the head will thus be equalized.

It will be seen therefore, that the invention provides a very simple and inexpensive method of timing cam mechanism and of so forming the cam that it is readily interchangeable. It is pre-

referred to for cams or other rotating members, wherein an angular adjustment device is provided between each of two or more gears of the driving train and the members on which they are mounted or to which they are operatively connected.

2. Timing mechanism as claimed in Claim 1, in which a sleeve having a splined connection with the driving member is interposed between the latter and a gear thereon the driving connection between the gear and sleeve being established by dogs whose number and that of the splines is other than a multiple or sub-multiple of the number of teeth in the pinion, for the purpose described.

3. Timing mechanism as claimed in Claim 1 or Claim 2 and for use in driving a cam in which the cam is loosely mounted upon the cam gear wheel and is operatively connected by a pin carried by the one part and selectively engageable with circumferentially spaced holes on the other part the number of holes being other than a multiple or sub-multiple of the number of teeth in the cam gear wheel.

4. Timing mechanism as claimed in Claim 3, in which the pin is carried endwise in driving engagement with the cam gear wheel by means of a resilient [illegible] located by contact with a bearing [illegible] cam spindle.

5. Timing mechanism substantially as described with reference to the accompanying drawings for use in driving cams or other rotating members substantially as described with reference to and as illustrated in the accompanying drawings.

Dated this [illegible] day of [illegible] 1928.

ERIC W. WALFORD,

[illegible]

Patent Agents,

[illegible] Street, London,

Agents for the Applicants.

Reference has been directed in pursuance of Section [illegible] of the Patents and Designs Acts, 1907 to 1comptroller's Specification No. 287,885.

Redhill: Printed for His Majesty's Stationery Office, by the Love & Malcomson, Ltd.—1928.

FIG.1.

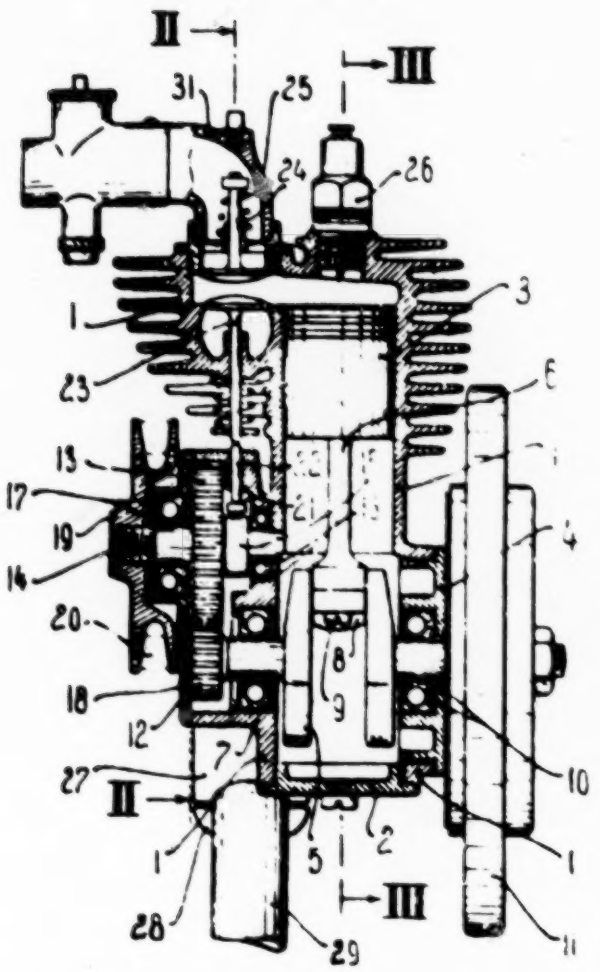
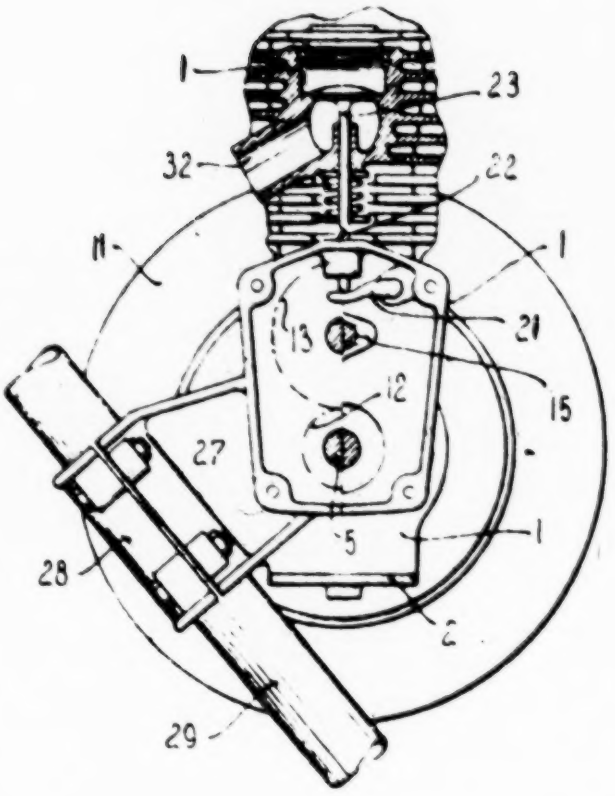


FIG.2.



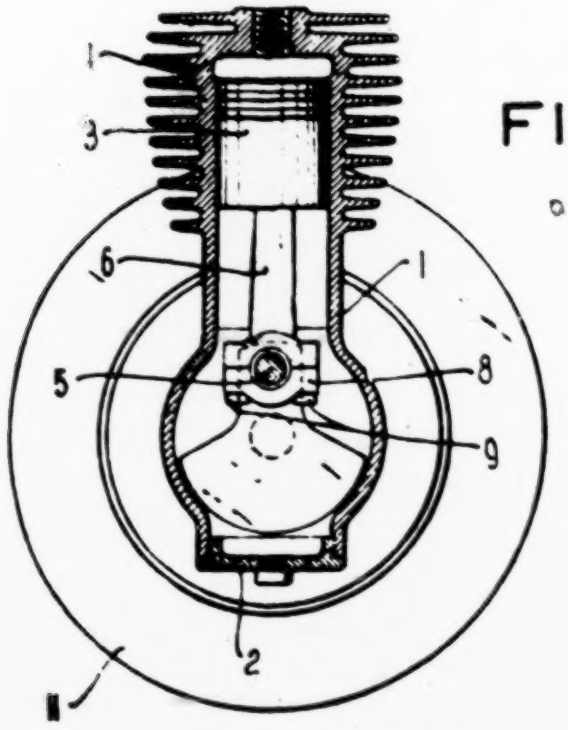


FIG.3.

Aanvrage 62173.

D. 621.434.12
621.43—22
621.431.73

Uitgegeven 15 Mei 1934.
Dagteekening 17 April 1934

Auteursrecht voorbehouden

OCTROOIRAAD

NEDERLAND

OCTROOI N°. 32802.

KLASSE 46 *a*. 6. (46 *c*. 4).

BILTHOVENSCHE METAALINDUSTRIE
te Bilthoven

Viertactverbrandingsmotor voor het drijven van een rijwiel of dergelijk doeleinde, waarbij de cylinder en de krukkast tot één hoofdgietstuk zijn vereenigd en de krukkast een door een deksel gesloten zijdelingsche opening bezit voor het naar binnen brengen van de krukas met een daarop aangebracht rondsel, dat in het tandwiel van de nokas grijpt.

Aanvrage 62173 Ned., ingediend 10 Augustus 1932, 14 uur 40 min.
openbaar gemaakt 15 December 1933

Het doel van de uitvinding is een kleine verbrandingsmotor, welke zoo eenvoudig is geconstrueerd, dat de aanmaakkosten laag en de montage bijzonder eenvoudig zijn. De grootst mogelijke betrouwbaarheid in het bedrijf wordt tevens nagestreefd. Een voorwaarde voor het bereiken van dit laatste doel is, dat de afwerking van de onderdeelen, niettegenstaande den lagen prijs toch zeer zuiver moet zijn.

Een viertactverbrandingsmotor van de in den titel omschreven soort is bekend uit het Britsche octrooischrift No. 153 685. Daarbij is de krukas éénzijdig uitgevoerd en de zijdelingsche opening in de krukkast door een dicht deksel met bouten gesloten. Het rondsel is op de krukas zelf uitgesneden en heeft dus dezelfde middellijn als deze.

Anderzijds is een tweetactverbrandingsmotor, ook met een éénzijdige krukas, doch met gescheiden cylinder en krukkast bekend uit het Fransche octrooischrift No. 321.400. Ook hierbij is in de krukkast een zijdelingsche opening gespaard, waardoor in schuine richting de éénzijdige krukas is gestoken en die vervolgens is gesloten door het krukasleger, dat daartoe van schroefdraad is voorzien.

Volgens de uitvinding wordt bij een motor van de eerstbedoelde soort de opening in de krukkast gesloten door een schroefdeksel, dat tevens een krukasleger, bij voorkeur een kogelleger, bevat.

Verder is volgens de uitvinding tusschen de kruk en het op de as bevestigde rondsel het tweede leger om de krukas aangebracht welk leger in een opening aan de andere zijde van de krukas geschoven is, waar het stuit tegen een naar binnen stekenden kraag van de krukkast, van welken kraag de binnenmiddellijn grooter is dan de buitenmiddellijn van het rondsel.

Deze constructie is goedkoop, omdat zoowel het deksel als de beschreven gedeelten van de krukkast op een draaibank kunnen worden afgewerkt. De centreering is onberispelijk. De montage is gemakkelijk en bij het aanschroeven van het deksel kan men voortdurend controleeren of de onderdeelen goed loopen met niet meer dan de noodzakelijke speling. De groote middellijn van de schroefverbinding en het groote draagvlak van het deksel in den krukkastwand voorkomen slijtage en lostrillen. Voor een kogelleger is in zulk een deksel ruim plaats, zonder dat de axiale lengte van den motor vergroot behoeft te worden.

Op de teekening is de uitvinding met een uitvoeringsvoorbeeld toegelicht.

Fig. 1 is een verticale langsdoorsnede.

Fig. 2 is een doorsnede over de lijn II—II in fig. 1 en verder een aanzicht. Enkele deelen zijn weggenomen gedacht.

Fig. 3 is een verticale dwarsdoorsnede.

De krukkast en de cylinder van den motor zijn vereenigd tot één gietstuk 1. Onder in de krukkast is een dop 2 geschroefd. De diameter van de daarmede afgesloten opening is zoo groot, dat de zuiger 3 door deze opening naar binnengeschoven kan worden.

Rechts in het gietstuk 1 bevindt zich een schroefdeksel 4, dat een opening afsluit, groot genoeg voor het doorlaten van de krukas 5. Wordt eerst de zuiger 3 met de drijfstang 6 naar binnen gebracht en vervolgens de krukas, waarop het kogelleger 7 en het rondsel 12 gemonteerd zijn, dan kan men de kap 8 van den drijfstang

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Prijs per ex. f 0.60

kop met de schroeven 9 bevestigen en deze laatste borgen. Het schroefdeksel 4 bevat het kogelleger 10.

Bij het inbrengen van de krukas 5 schuift het rondsel 12 door de opening, gevormd door den kraag 30, maar het kogelleger 7 stuit tegen dien kraag. Aldus wordt de krukas tusschen de legers 7 en 10 opgesloten.

Op het deksel 4 worden (niet geteekende) spoelen van den vliegwielmagneet-ontsteker bevestigd. Het vliegwiel 11 bevat den magneet en den onderbreker.

Het rondsel 12 werkt op het rad 13 met een overbrenging van één op twee. De as 14 van het rad 13 is voorzien van de nokschijf 15 en draagt in de kogellegers 16 en 17, waarvan het laatste in het deksel 18 ligt. In afwijking van de teekening kan deze afdekking gedeeltelijk één geheel met het gietstuk 1 vormen en kan het kogelleger 17 zijn gevat in een schroefdeksel van het type van deksel 4. De snaarschijf 19 is op de nokas 14 gemonteerd. De snaar 20 krijgt derhalve matige snelheid.

De tusschenhefboom 21 brengt de beweging van de nok 15 over op den klepstooter 22, die weder op de stang 23 van de uitlaatklep werkt. De inlaatklep 24 staat onder den invloed van de veer 25. De bougie 26 geeft bij iedere omwenteling een vonk, hetgeen niet hinderlijk is.

Aan het hoofdgietstuk 1 bevindt zich een aangegoten schuine stoel 27. Deze en de bijbehoorende kap 28 omvatten de schuine stang 29 van het rijwielgeraamte.

Uit de teekening blijkt, dat montage en demontage van den motor in zeer korten tijd kunnen geschieden. Bij montage van het schroefdeksel 4 kunnen geen fouten worden gemaakt. Het rondsel 12 kan, nadat het kogelleger 7 op de krukas is geschoven, dadelijk worden vastgezet, omdat het door den kraag 30 in het hoofdgietstuk 1 geschoven wordt bij het inbrengen van de krukas.

Conclusies.

1. Viertactverbrandingsmotor voor het drijven van een rijwiel of dergelijk doel, einde, waarbij de cylinder en de krukkast tot een hoofdgietstuk zijn vereenigd en de krukkast een door een deksel gesloten zijdelingsche opening bezit voor het van binnen brengen van de krukas met een daarop aangebracht rondsel, dat in het tandwiel van de nokas grijpt, met het kenmerk, dat de opening in de krukkast is gesloten door een schroefdeksel, dat tevens een krukasleger, eventueel kogelleger bevat.

2. Viertactverbrandingsmotor volgens conclusie 1, met het kenmerk, dat tusschen de kruk en het op de as bevestigde rondsel het tweede leger, eventueel kogelleger, om de krukas is aangebracht, welk leger in een opening aan de andere zijde van de krukas is geschoven, waar het stuit tegen een naar binnen stekenden kraag van de krukkast, van welken kraag de binnenmiddellijn grooter is dan de buiten middellijn van het rondsel.

Hierbij 1 blad teekeningen.

Department of Commerce

UNITED STATES PATENT OFFICE

TO ALL PERSONS TO WHOM THESE PRESENTS SHALL COME, GREETING:

THIS IS TO CERTIFY that the annexed is a true copy from the records of this office of an Official Translation of Netherlands Patent No. 32,802, dated August 10, 1932, to Bilthovensche Metaalindustrie, for Four-cycle combustion motor for driving a bicycle or for a similar purpose, in which the cylinder and the crankcase are united to form a main casting and the crankcase possesses a lateral opening closed by a cover for inserting the crankshaft with a pinion mounted thereon, engaging with the gearwheel of the camshaft.

IN TESTIMONY WHEREOF I have hereunto set my hand and caused the seal of the Patent Office to be affixed at the City of Washington, this third day of February, in the year of our Lord one thousand nine hundred and fifty-five and of the Independence of the United States of America the one hundred and seventy-ninth.

ATTEST:

(Sgd) C. T. Rains
Head, Manuscript and
Lithographic Branch.

ROBERT C. WATSON
Commissioner of Patents.

Translation of Netherlands Patent No. 32,802, Class 46a-6 (46c-4), to Bilthovensche Metallindustrie, Bilthoven; application Netherlands 62173 filed August 10, 1932; laid open to inspection December 15, 1933; published May 15, 1934; date of patent April 17, 1934.

Four cycle combustion motor for driving a bicycle or for a similar purpose, in which the cylinder and the crankcase are united to form a main casting and the crankcase possesses a lateral opening closed by a cover for inserting the crankshaft with a pinion mounted therein, engaging with the gearwheel of the camshaft.

The object of the invention is a small combustion motor, which is so simply constructed, that the costs of manufacture are low and the assembling is particularly simple. The utmost reliability of operation is sought at the same time. A condition for attaining this last goal is that the making of the parts, despite the low cost, should be of the highest quality.

A four-cycle combustion motor of the type described in the title is disclosed in British Patent No. 153685. In this case the crankshaft is made one-sided and the lateral opening in the crankcase is closed by a tight cover with bolts. The pinion is out in the crankshaft itself and thus has the same center line.

On the other hand, a two-cycle combustion motor, also with a one-sided crankshaft, but with a separate cylinder and crankcase, is disclosed by the French Patent No. 321400. In this case also a lateral opening is left in the crankcase, through which the one-sided crankshaft is inserted obliquely and which is then closed by the crankshaft bearing, which is therefore provided with screw thread.

According to the invention in a motor of the type first mentioned the opening in the crankcase is closed with a screw cover, which at the same time receives a crankshaft bearing, preferably a roller bearing.

Furthermore, according to the invention, between the crank and the pinion attached to the shaft a second bearing is arranged around the crankshaft, which is inserted in an opening in the other side of the crankshaft, where it stops against an inwardly projecting collar of the crankcase, whose internal center line is greater than the external center line of the pinion.

This construction is cheap, because both the cover and the parts described of the crankcase can be finished on a lathe. The centering is perfect. The mounting is easy and in screwing on the cover we can constantly check whether the parts are working well with not more than the necessary clearance. The long center line of the screw connection and the large bearing surface of the cover in the crankcase wall prevent wear and shaking loose. In such a cover there is ample room for a ball bearing, without the necessity of enlarging the motor.

The invention is illustrated on the drawing in an embodiment. Figure 1 is a vertical longitudinal section. Fig. 2 is a cross-section following line 11-11 in Fig. 1, and also an elevation. A few parts are supposed to be removed. Fig. 3 is a vertical cross-section.

The crankcase and the cylinder of the motor are united in a casting 1. A cap 2 is screwed on underneath the crankcase. The diameter of the opening thus closed is so great, that the piston 3 can be inserted through this opening.

To the right in the casting 1 there is a screw cover 4, closing an opening, which is large enough to admit the crankshaft 5. If the piston 3 with the driving rod 6 is first placed inside and then the crankshaft, on which the ball bearing 7 and the pinion 12 are mounted, then the

cap 8 of the head of the driving rod can be fastened with screws 9 and secure it. The screw cover 4 receives the ball bearing 10.

In introducing the crankshaft 5 the pinion 12 slides through the opening formed by the collar 30, but the ball bearing 7 stops against this collar. The crankshaft is thus enclosed between the bearings 7 and 10.

Coils (not shown) of the flywheel magnet igniter are attached to the cover 4. The flywheel 11 contains the magnet and the switch.

The pinion 12 acts on the wheel 13 with a transmission ratio of one to two. The shaft 14 of the wheel 13 is provided with the cam disk 15 and enters the ball bearings 16 and 17, of which the latter lies in the cover 18. As a variation from the drawing this cover may in part form a whole with the casting 1 and the ball bearing 17 may be contained in a screw cover of the type of the cover 4. The sheave 19 is mounted on the cam shaft 14. The rope 20 thus obtains moderate speed.

The intermediate lever 21 transmits the movement of the cam 15 to the valve lifter 22, which in its turn acts on the stem 23 of the exhaust valve. The inlet valve 24 is under the influence of the spring 25. The spark plug 26 at every revolution produces a spark, which causes no trouble.

An oblique cradle 27 is cast on the main casting 1. The latter and the appertaining cap 28 enclose the oblique rod 29 of the bicycle frame.

From the drawing it appears that the mounting and dismounting of the motor can take place in a very short time. In mounting the screw cover 4 no errors are made.

The pinion 12, after the ball bearing 7 has been inserted on the crankshaft, can be definitely secured, because it is inserted through the collar 30 in the main casting, when the crankshaft is introduced.

PATENT CLAIMS

1. Four-cycle combustion motor for driving a bicycle or for a similar purpose, in which the cylinder and the crankcase are united to form a main casting and the crankcase possesses a lateral opening closed by a cover for inserting the crankshaft with a pinion mounted thereon, engaging with the gearwheel of the camshaft, characterized thereby, that the crankcase is closed by a screw cover, which at the same time receives a crankshaft bearing, which may be a ball bearing.

2. Four-cycle combustion motor according to patent claim 1, characterized thereby, that between the crank and the pinion attached to the shaft a second bearing is arranged around the crankshaft, which may be a ball bearing and which is inserted in an opening in the other side of the crankshaft, where it stops against an inwardly projecting collar of the crankcase, whose internal center line is greater than the external center line of the pinion.

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